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Fourteenth Bi-Annual Meeting of CIB Commission W-14 (Fire) May 19 - 23, 1980

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National Engineering Laboratory
National Bureau of Standards
U.S. Department of Commerce
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U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, ***Secretary***

Luther H. Hodges, Jr., ***Deputy Secretary***
Jordan J. Baruch, ***Assistant Secretary for Productivity, Technology, and Innovation***

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, ***Director***

FOURTEENTH BI-ANNUAL MEETING OF CIB COMMISSION W-14 (FIRE)
MAY 19 - 23, 1980

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Abstract

A summary is presented of the discussions during the 14th Meeting of CIB Commission W-14 on Fire in Athens, Greece. A total of 48 delegates from 14 countries exchanged information on building fire safety during Group and Plenary Meetings covering the following topics: building codes; fire costs; fire loss statistics; fire engineering education; structural fire protection (including material properties, classification of structures, calculation rules, and full-scale fire tests); smoke control and emission; and mathematical modeling. Three workshops are planned during 1981 to cover the topics "Fire Safety Design," "Fire Engineering Education" and "Modeling of Fires." A list of papers circulated to delegates during the last two years is included for reference.

Key words: Buildings; building codes; CIB; Commission W-14; education; fire endurance; fire loss statistics; fire modeling; fire safety; fire tests; smoke control.

FOURTEENTH BI-ANNUAL MEETING OF CIB COMMISSION W-14 (FIRE)
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Opening Plenary Session

The 14th meeting of Commission W-14 on Fire of the CIB was convened on May 23, 1980 at the Research Foundation Building in Athens, Greece. All other meetings were held in the offices of the host organization, the Technical Chamber of Greece. There were a total of 48 delegates from 14 countries. (See Appendix A). The U.S. was represented by D. Gross (NBS), P. S. Shaenman (USFA) and Dr. E. L. Schaffer (USDA/FPL).

The list of papers circulated to delegates since the 13th meeting in Lyngby 1978 is included as Appendix B. Although there was no final form of the Agenda, the meeting followed the pattern of previous meetings in which the first day was a General Plenary Session involving all delegates. The next two days were taken up with two concurrent group sessions led by individual chairmen and rapporteurs:

Group I Structural Matters (chaired by Mr. Malhotra)
- Properties of Materials (Harmathy)
- Classification of Structures (Twilt)
- Calculation Rules (Pettersson)
- Full-Scale Tests (Adam; not present)

Group II Non-Structural Matters (chaired by Mr. Becker)
- Smoke Control and Emission (Majou)
- Mathematical Modeling (Magnusson)

A fourth day involved all delegates reassembled in Plenary Session and covered a review of the Group I and Group II discussions plus topics of general interest. These topics were: Fire Costs and Fire Loss Statistics; Fire Protection Education; Fire Safety Panel; and Future Activities.

A welcome address was given by Mr. Kalogeras, a former Vice President of the Technical Chamber of Greece. As official advisor to the Government, the Chamber is currently drafting a Fire Protection Code and Mr. Kalogeras outlined the nature of the fire problem in Greece. He indicated that traditional earthquake-resistant, mainly noncombustible buildings were used in Greece, and that perhaps Greece had been protected from fire by its ancient Gods. While the fire casualty rate was presently quite low he noted that the introduction of new materials such as plastics was an unknown question for the future.

At the opening Plenary Session Dr. Thomas suggested that a shorter meeting report would be prepared, in part to ease the load on the Coordinator. Dr. Thomas mentioned the forthcoming 8th CIB Congress in Oslo, June 1980 and noted that fire was not an agenda item. He also indicated that operational changes had been introduced by the CIB Board regarding the

work of Coordinators. Mention was made of the CIB Board position on the relationships between CIB and ISO in terms of research versus standardization and that CIB should try to strengthen its links with ISO at the policy making level while clearly delineating its basic roles. Along these lines, Dr. Thomas reviewed the recent ISO/TC 92 resolutions dealing with cooperation and common areas of interest between TC 92 and CIB W-14, as well as the role of ISO Technical Division 3 in recommending the preparation of International Standard Codes for fire precautions in buildings. A general discussion on this topic indicated that there were differences in interpretation and questions of jurisdiction which might be resolved by formulation of a position of the CIB W-14 Fire Safety Panel, aided by a CIB symposium on this topic.

The role of the CIB W-14 group on Modeling was discussed and it was stated that this group should develop scenarios for validating and describing typical fire hazards, e.g., fire spread on an exterior wall; development of flashover; etc. The appropriateness of using numerical values from standard fire tests was also discussed. It was noted that CIB W-14 would formally send the report of the Modeling group to ISO TC 92.

Mr. Malhotra reported on behalf of the Code Advisory Panel. He noted that the FIP Commission had published a design guide in 1978 dealing with reinforced concrete construction. FIP is currently working on means for introducing analytical procedures into the guide. Work on analytical calculations for steel structures is proceeding well with strong input from the CIB W-14 Code Advisory Panel (particularly since Prof. Witteveen is Chairman) and this is expected to be published shortly. With regard to wood structures, the first draft of a design guide prepared recently by CEI-Bois is to be discussed at a meeting in Brussels on June 2. It is anticipated that suggested changes will be made in order that the CEI-Bois Design Guide will agree with the Code Advisory Panel input. In the area of masonry structures it was noted that the UK member of CIB 23A will be making suggestions. Copies of the CEI-Bois Draft Code will be made available as soon as clearance for its release is obtained. The distribution and availability of CIB W-14 Document 78/78 dealing with codes needs to be formally decided during this meeting.

With regard to the acceptance of codes by regulatory bodies it was noted that three questions need to be considered. There are separate routes to permit acceptance of analytical methods by regulators: (a) fire resistance tests, (b) analytical computations of fire resistance and (c) analytical computations of fire severity. Dr. Harmathy noted that analytical procedures do not belong directly in building codes since these are legal documents to protect the public and should be separate documents which may be referenced. Mr. Kalos noted that most regulatory officials are not prepared to work with analytical methods in computer design. It was noted that this discussion would form a prelude to the Group I discussions and additional discussion was postponed until then.

With regard to large-scale structural tests, these will also be discussed in Group I and the preferred terminology was stated to be "Large Size Fire Simulation Tests."

Prof. Witteveen gave a brief background of the work of the Fire Safety Panel and noted that this was scheduled to meet later in the week. He reviewed the need for formal liaison with other groups such as CTIF, CEA and AE. He noted that since there was no international organization of regulatory bodies it was necessary for individual CIB W-14 members to contact their national regulatory officials to suggest participation in meetings for the purpose of exchanging information. Mention was made of the need to organize informal workshops of less than 20 participants on several subjects such as: (a) validation of test results; (b) trade-offs between passive and active fire protection systems; (c) acceptable levels of fire safety; and (d) analytical calculation methods. These workshops would invite individual experts who would not be official representatives of their company, organization, or association. It would be planned to circulate the reports of these workshops in order to enhance the prestige of CIB W-14. With regard to the response of certain liaison groups, e.g. the insurance industry, to cooperative activity with the Fire Safety Panel, Prof. Witteveen indicated that the insurance group was reluctant to cooperate fully and that there was still a lot of work to be done to get the dialogue going. Dr. Thomas indicated that in certain cases members of the insurance industry had been in attendance at CIB W-14. He also mentioned that the Eurolarm Committee on Detection and the Eurofire Committee on Suppression are interested in developing grading systems. The UK representative has asked CIB W-14 if they were in a position to offer help. It was considered possible for the Fire Safety Panel to provide advice, possibly through Mr. Erik Pedersen who is a member of the Committee. Discussion on the Fire Safety Panel ended following a lively session dealing with the role and ability of CIB W-14 to provide advice and information to regulators in a form which they can and will use and the need to consolidate national contacts with regulatory officials.

Prof. Sugawara reported on the Tsukuba Symposium in August 1979 on the subject of Systems Approach to Fire Safety in Buildings. He noted the presence of a number of regulatory officials from the Ministry of Construction in Japan as well as Mr. Bihr representing the International Conference of Building Officials from the U.S. He also noted that Dr. Wakamatsu was Chairman of the JAFSE Panel on Systems Approach. Dr. Thomas noted the excellent organization and resultant success of the Tsukuba Symposium and thanked everyone who was involved in making it a success. Dr. Thomas also noted the future availability of a Japanese text book for which individual chapters have been translated by cooperating laboratories in France, U.S. and U.K. He also noted that a U.K. publisher has expressed an interest in publishing a second edition if and when this becomes feasible. Dr. Thomas noted that copies of the available translated chapters could be requested by individuals. Although there will be no charge for these chapters, he requested that two copies be returned instead of one to permit use by others. He also inquired as to whether any English or French translations were available of Chapter 4 on Fire Resistance written by Kawagoe and Saito.

Current Activities

At this session delegates from each country were asked to summarize their current fire related activities in research, testing and standards. Although this was not a fully structured agenda item, most delegates were happy to have such a session, particularly those attending for the first time. Several prepared summaries of activities were available as handouts (See Appendix C for information provided by Australia, Denmark, Finland, Germany, Greece, Japan and U.S./FPL).

Dr. Thomas for the U.K. noted problems in the funding of fire research due to budgetary cuts and staff limitations. He was pleased to note that he had Mr. Papaioannoy, a guest worker from the University of Thessaloniki at the Fire Research Station at the present time. Additional information on U.K. fire research activities was provided later by Mr. Malhotra.

Mr. Keough reported that Australia had increased its fire research activities. In addition to the work at the Experimental Building Station, work was also in progress at the CSIRO labs on topics including furniture and upholstery flammability, wall linings and toxicity. A special group was working on textiles such as transportation vehicle fabrics. In the area of statistics he noted that fire losses were actually one-half of that previously reported. He mentioned the EBS program on the behavior of loadbearing masonry walls in which partially loaded walls were more critical under fire exposure than unloaded or fully loaded walls. He noted that the implementation of research findings usually does not progress fast enough and that EBS is concentrating on this. He also noted that hot dry summers result in brush fires but that there had been limited life loss due to the experienced fire fighting forces available in Australia.

Dr. Harmathy from Canada noted that the center of interest at the Fire Research Section was on the properties of materials. He mentioned new modern instruments for performing thermal analysis; also a new column testing furnace and a cooperative program with Portland Cement Association; also a field station now under construction consisting of a 10-story tower available for studies of smoke movement and control and space for studying the fire drainage principle and the effectiveness of flame deflection devices. In a large Burn Hall, studies of furniture flammability and measurements of gaseous combustion products will also be undertaken. Emphasis is also being placed on knowledge of fire plumes and on ignition.

Mr. Reichel discussed fire-related activities in Czechoslovakia. These are separated into a) fire research, b) standards and c) fire testing. There are two labs in the Ministry of Interior where material tests are performed from the point of view of the fire brigades. Mr. Reichel's institute prepares standards. A special committee consisting of delegates from the Ministry of Interior and experts on buildings and design are involved in large-scale fire simulation tests of fire spread on facades and the development of a time-temperature curve in a burn room. The fire

resistance of structures is calculated and compared with experimental results. Work is also underway on the behavior of materials. A book (in German) has been prepared describing the large-scale fire experiments and corresponding calculations and it is expected to be available next year.

Mr. Dano from Denmark mentioned the work of the National Institute of Testing Materials and its recent merger with the National Bureau of Weights and Measures into an independent organization called DANTEST, the National Institute for Testing and Verification. This is supported by industry test fees and Government grants. In terms of test method research, highest importance is given to reaction to fire tests. Mr. Pedersen, representing the Danish Joint Fire Protection Association noted that this association was recently approved by the Government Council on Research and now receives government research funds. They are involved heavily in fire statistics, systems approach and risk analysis, and are working on a structural code to be completed in 1980. Prof. Olesen, head of the Fire Laboratory at Aalborg University Center distributed a preprint on current activities including studies on concrete, steel and wood structures. Prof. Jakobsen from the Technical University of Denmark mentioned the work in heating and ventilation on a "zero energy" house and on structures, notably light sandwich panels and concrete structural design.

Mr. Loikkanen from Finland prepared a handout and indicated that the National Technical Research Institute had a staff of 32 working on projects including the fire resistance of gluelam timber structures, the behavior of concrete structures, tests for portable extinguishers, chimneys and fireplace safety, dust explosion research and textile flammability, including drapery, sleeping bag and upholstery fabrics.

Mr. Rilling from France summarized the research going on at CSTB involving a staff of 35; at UTI where studies are undertaken on fire resistance, smoke control and risk evaluation; and at CTICM where a staff of two are involved mainly with conventional fire resistance tests. Active projects include the development of full-scale fire growth tests for correlation with small-scale tests, the use of a corner test and of small-scale material tests. Work is also underway on comparing smoke in large and small chambers. There is active work on a computer program on smoke movement in buildings and a coordinated French effort on modeling. Mr. Rilling indicated that CSTB is moving more toward calculation and analytical approaches and away from testing.

Mr. Becker reported that in Germany several state institutes perform particular fire tests and that there is a greater emphasis now on industry participation. He mentioned work on: fire resistance including reliability analysis; measurement of heat contribution; animal testing in cooperation with industry efforts in Ghent and Aachen pointing toward a European standard; studies on the evacuation process; and also the effects of ventilation and pressurization being done at the University of Karlsruhe. He mentioned the fire response of total systems by Haksever at Braunschweig; the draft model code; work on standardized structures to

be promulgated as a DIN Standard; work on fires in transport systems; studies on sprinkler systems as a response to the recent Ford Company fire in Germany and work on strategic restructuring of fire brigades in terms of equipment needs.

Mr. Papaioannoy described the program at the Technical University of Thessaloniki, Greece, where he is Professor of Engineering Materials. He indicated that forest fires represent the main problem and that no large increase in research funding was anticipated. He is looking toward organizing a fire research organization in Greece. At the University of Thessaloniki, the subject of fire safety is currently touched on in the Department of Building Construction and Materials, which includes Architecture, Civil Engineering and Topography (agronomy and land management). One particular area of interest is the design of special buildings (hotels, hospitals, schools, factories).

Dr. Kovacs from Hungary indicated that his Institute for Quality Control had a 5-year plan and notable activities included smoke generation classification and toxic hazards using the ISO smoke box, differential thermal analysis, and combustion product analyzers. They also have a cooperative program with Poland in which the bodies of coal miners involved in a fire have been exhumed. In response to a question on their facade testing facilities, Dr. Kovacs indicated that only 6 or 7 tests have been conducted over the past 2 1/2 years, since this is a specialized test facility and is subject to the influences of wind and weather.

Prof. Sugawara from Japan prepared a handout indicating building fire research activities in Japan, classified according to originating organization: The Japanese Association of Fire Science and Engineering; the Architectural Institute of Japan; selected Administrative Committees; and special (individual) activities.

Prof. Witteveen gave a short summary of fire studies, both structural and nonstructural, in the Netherlands.

Prof. Pettersson from Sweden indicated that, following the development of a structural design handbook for fire, there was a general trend away from structural fire research and testing in Sweden. He felt that this was a trend also observable in France, the U.S. and other countries.

Short summaries of activities in the U.S. were provided by Gross, who described the recent reorganization of the Center for Fire Research into three Divisions and an Office of Exploratory Research; by Dr. Schaffer on the activities at Forest Products Laboratory (these activities were also summarized in a handout previously circulated); and by Mr. Schaenman who gave a brief review of the research activities at the U.S. Fire Administration.

Group I. Structural Matters

A. Properties of Materials

This topic was discussed by Dr. Harmathy as rapporteur, and covered the high temperature properties of steel, masonry, concrete and wood, including CIB Documents 79/15, 79/24, 79/25, 80/20, 80/28, 80/29, 80/30 and 80/40. In the discussion period on the Japanese reports on structural steel, Prof. Witteveen pointed out the need to express creep equations in a practical way suitable for engineering use. He suggested that the difference between results at heating rates from 2 to 10°C/min was small. Prof. Olesen mentioned a report dealing with dowel fasteners in wood members in which a heated steel rod was pressed into wood blocks and the rate of combined charring and embedment was measured as a function of steel temperature.

B. Classification of Structures

This topic discussion was led by Dr. Twilt from TNO as rapporteur. His review was based on CIB Documents 79/45, 79/26, 80/4, 80/3 and an article entitled "On the Fire Resistance of Structural Steel Elements Derived from Standard Fire Tests or by Calculation" by Pettersson and Witteveen published in Fire Safety Journal, Vol. 2, pp. 73-87. Twilt indicated that the main trend with regard to thermal structural behavior was from laboratory testing to analytical calculations; with respect to requirements, the trend was from a global to a differentiated approach. He listed the following features (disadvantages) of the experimental approach: 1) variation of test results (specimens and furnaces); 2) difficulty in generalization; 3) limited application including (a) limited size and experimental facilities, (b) limitations in loads, and (c) no controlled restraint; and 4) expense. He listed the features of the analytical approach as 1) unambiguous calculated results; 2) simple generalization; 3) negligible cost; and 4) the disadvantage of lack of knowledge of the physical processes involved. He then compared the function of a structural element (loadbearing only, separating only, or combined loadbearing and separating) and its criteria for structural capacity, integrity and insulation in terms of whether the experimental and/or analytical approaches were used and suitable. He then surveyed the use of analytical classifications in various national and international codes. This is shown in the attached table, revised according to the inputs of the delegates present. Twilt considered that it was possible to list three levels of classification of structures for fire resistance. Level 1 refers to the use of the standard fire endurance test, level 2 is a combination of testing and analysis, and level 3 is a complete analytical calculation procedure based on the anticipated natural fire exposure.

Table 1. Analytical Classification of Structural Elements
Survey of Current and Future Uses by Year of Acceptance

National Codes	Concrete	Steel	Timber
Sweden	1978	1974	1978
France	1974	1976	--
U.S.	1977	1980	--
U.K.	1978[a]	1979	1978
Netherlands	1981?	1981?	1981?
Austria	--	1979	--
International Codes			
FIP/CEB	1975/78		
ECCS		1980	

Notes: Underlining refers to use of a theoretical basis

[a]Unofficial, unless accepted by code authorities

The characteristics of the level 1 approach are 1) common practice; 2) consistency between the different components (i.e., doors are rated in the same way as walls and columns) and 3) considerable background information has already been developed. The conditions necessary for the successful application of the calculation method of level 3 involves 1) simplicity; 2) consistency. Several examples were given of the agreement between calculation and experimental results. It was noted that the basis of the ECCS recommendation (level 1) were (a) use of ISO 834 Fire Resistance Test, (b) assumption of constant thermal properties, (c) assumption that steel properties were independent of time, and (d) uniform temperature distribution. In this way a very simple criterion based on a critical temperature is possible. He then made a comparison to show the discrepancy between calculation and test as follows.

Calculation	Test
Characteristic values of material properties	Random sample of materials (and properties)
Uniform temperature distribution	Non-uniform temperature distribution
Characteristic imperfection	Random imperfections

In summary he noted that the required fire duration depended upon (a) the occupancy, (b) environmental factors (height and volume), (c) fire fighting, (d) physical factors including fire load density, type of combustion, thermal insulation and ventilation, and (e) safety factors.

In the discussion period it was noted that in natural fires the complete structure is exposed whereas in ISO 834 only the tested components. Also that there is a problem in using correction factors (first order vs second order) to adjust the calculated value to agree with the experimental value, since they are not broadly applicable and are based on test results from particular furnaces which are different and have different end conditions. Nevertheless Witteveen pointed out that since tests are very pragmatic then a pragmatic correction factor is reasonable even if not totally precise. Prof. Pettersson pointed out that calculations are based on characteristic values or design values and differences may be adjusted either from calculation to available test data or by using design values and then recalculating the result of the standard test.

It was pointed out by Schneider and Kersken-Bradley that in Germany two ISO 834 tests are conducted and therefore the statistical approach is different. There was a discussion also on the definition of characteristic value and whether this represents a minimum guaranteed value,

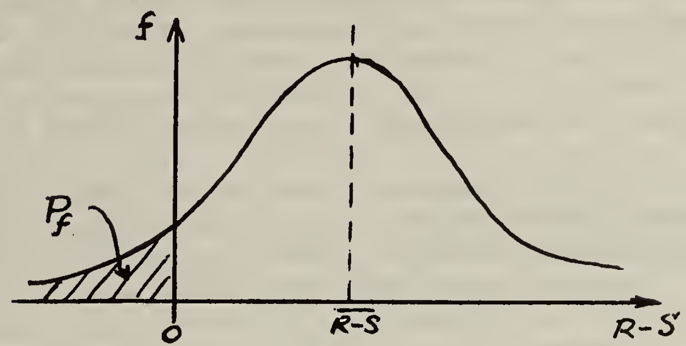
especially for timber at elevated temperature. Dr. Schaffer made observations about the variability of load application; the probability that the maximum design load would occur at the time of the fire; and the fact that in the U.S. ANSI A58 is discussing load factors for timber and will make recommendations.

C. Calculation Rules

Prof. Pettersson was the rapporteur dealing with calculation rules. He updated his previous review (Document 78/86) and noted that fire response is nondeterministic and can be expressed in probabilistic terms.

Here, S = variability in fire load
R = variability in fire resistance

The safety index is represented by P_f, or the region where (R - S) < 0.



In the German Draft Model Code, Document 79/45, the basic stated principle is that the structure is designed to maintain integrity before and after fire, with an effective fire duration which takes into account safety, extinguishment and environmental factors. The equivalent fire duration is expressed as:

$$t_a = q \cdot m \cdot w \cdot c$$

where q = total fire load
m = dimensionless burning factor
w = heat exhaust factor
c = conversion factor

The required fire resistance time, in minutes, is expressed as:

$$t_f = t_a \cdot \gamma \cdot \gamma_{nb}$$

where γ = safety factor (reliability, building type and use)
γ_{nb} = correction coefficient for deviations

Prof. Pettersson also mentioned other papers and research. Harmathy has plotted gas temperature for various air flow rates. Pettersson has shown how temperatures developed in (insulated) steel compartments vary with ventilation factors. Harmathy illustrated how fires escape from compartments (barrier failure, through open windows and doors). Several

papers examined the effect of size of compartment. Research is underway at Braunschweig on small and large compartments in postflashover fires. Margaret Law presented a review of exterior fire exposure design of steel columns and beams at the last CIB meeting. Based upon Law's study, publication (80/25) was prepared by AISC as a design guide.

With regard to temperature-time response of structural elements, concrete slabs were examined by Jakobsen using a computer analysis. Hagglund and Jansson in Document 80/38, examined protection provided by a shelter added to a building subjected to an exterior fire. Analyzing fire response of structural elements using finite element methods is being done in California. Document 79/37 used a forward finite element program for concrete. Structures comprised of one or more materials plus voids can be analyzed. Schneider asked how moisture migration was considered in the analysis? It was stated that moisture was vaporized in the interior in porous materials and does not make a practical difference.

Harmathy believed we should not always assume fires are ventilation-controlled. This would be so for small rooms, but not for large rooms. For char forming materials, there is no such thing as insufficient oxygen for pyrolysis. This point will be discussed further later. Steel columns with and without axial restraint have been examined, as well as beams. Document 79/24 discusses geometrical dissimilarities in the response of steel beams and deformation behavior including creep and strain-hardening are described. Reinforced concrete structures are being investigated at Braunschweig. Elements include several types of columns and prestressed beams. Richter investigated prestressed concrete beams and results are given in curves of strand temperature at center span for standard fire exposure. Haksever has investigated concrete columns having various end fixity moments and eccentrically loaded conditions.

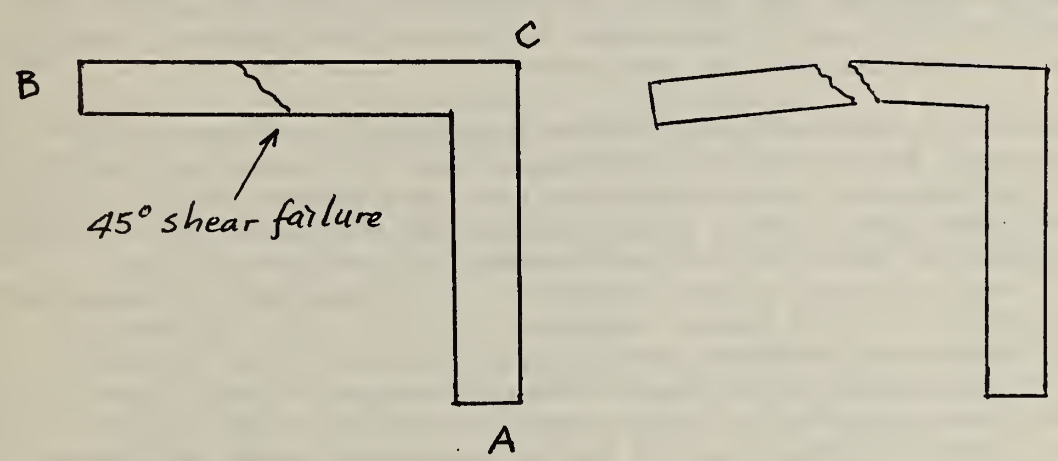
Bresler (Document 80/32) analyzed reinforced concrete slabs using a finite element and step-by-step integration technique. Damage, such as cracking and damage to reinforcement, can be predicted. A comprehensive test series of concrete beams was described by Lore Krampf. Compressive strength and bond strength is given as function of temperature.

Publications on fire-exposed wooden structures include several on charring of wood: Hadvig '76, Freedman '77, White/Schaffer '79. Wooden beams and columns have been investigated. (Haksever and Freedman). Design diagrams are given for columns with various end fixity. Buckling is given as function of charring, plus beam width and height.

Following Prof. Pettersson's presentation there was an active discussion. He agreed that there are very few studies and papers on the testing and analysis of complete structures, which take into account the interaction between structural elements, such as columns and floor slabs, or walls and floor slabs. However, he noted there were a few examples of such studies in Japan; at the University of Braunschweig; and at the University of California Berkeley. Dr. Anderberg noted that the calculated and

experimental restraint forces are not in good agreement but that investigations are underway to clarify this and furthermore, the prehistory of stress in concrete is very important. Dr. Haksever indicated that there is a gap between the calculated results using small-scale property values, and large-scale experimental results. The major differences are due to the rate of heating of concrete; in reality this is rapid but in laboratory tests this is done relatively slowly. He is trying to evaluate this effect by using special embedded electrical heating techniques in his laboratory at Braunschweig. Dr. Schneider indicated that the existence of holes, i.e., the dimension of the aggregate, was more important than the rate of heating. Dr. Schaffer pointed out that materials research almost always deals with homogenous materials and properties that are suitable at a given point. It was noted that there is very little research at present on concrete spalling.

Dr. Haksever illustrated some recent experimental and analytical studies that he had done at Braunschweig using a reinforced concrete inverted L frame. The column was loaded according to the DIN standard with an increased bending moment at the end of the beam. This is a statically indeterminate structure which is hinged and fixed at A and B as shown in the accompanying sketch with forces simulated at A, B and C in the



calculations. It was noted that a 45° shear failure occurred in the beam and that stirrups were ruptured. The conclusion was that fire tests of single elements are not sufficient to predict the response of a frame made up of those elements since there are drastic changes in shear forces upon fire exposure. Mr. Keough questioned whether by modeling, i.e. using short span constructions and increased load to develop the same bending stresses, the shear forces were not increased out of proportion. In the discussion it was not clear whether Dr. Haksever was using a full size beam but a report will be available to CIB W-14.

D. Full-Scale Fire Tests

In the group discussion on the subject of full-scale tests and real fires, the assigned rapporteur, M. Adam from France, was not present. Mr. Malhotra asked several individuals to give brief summaries of work that fit into the general category of full-scale tests. Gross gave a brief summary of CIB paper 80/12 dealing with Sprinklers in Health Care Facilities. Mr. Eric Pedersen questioned whether predictions had been made of smoke movement in these tests. I replied that no predictions were made and that it was necessary to perform the tests first since they were difficult to predict. However, we had made predictions of sprinkler response time since these were easy to compute from temperature curves. Mr. Keough gave a summary of his paper 80/56 in which a study was made of the difference between multipoint detectors which are standard for industrial occupancy vs. commercial U.S. single point detectors for homes. His conclusion was that single point detectors operate satisfactorily in terms of time response and provide a suitable sound level. Prof. Witteveen indicated that TNO had developed a hypothetical design of an exterior steel frame building and this will be sent for comment both to Margaret Law, representing AISI, and to Mrs. Krampf at Braunschweig. It was inferred that the Braunschweig analysis of the Lehrte test results did not agree with Miss Law's prediction method. On the other hand, Miss Law has shown that her method does correctly predict test results according to Prof. Pettersson.

With regard to "large-scale" fire simulation tests, Dr. Harmathy felt that they should be categorized according to the test object and specific aspect, that this was a more natural division since "large-scale" is only a relative size effect. Gross indicated that validation was the critical word. Whether the test involved preflashover or postflashover, and whether it was structural or non-structural, it is necessary to determine if the laboratory test of simple components or of a single response or "property" adequately simulates the full-scale behavior. Mr. Reichel said that it was difficult to reach a general conclusion from a few large-scale tests and that it is necessary to conduct a large enough series to achieve confidence in the use and extrapolation of the results. Prof. Pettersson mentioned that ISO TC 92 has received a useful guidance document for preflashover tests, namely, ASTM E 603, and that two years ago it requested CIB W-14 to provide similar guidance for postflashover tests. He felt that because of progress in the last two years, this need is not as pronounced. Prof. Witteveen considered all full-scale tests as "research tests."

On the subject of real fires, mention was made of the Bresler analysis of the Military Personnel Records Center fire. Dr. Schneider mentioned a two year old project at the University of Braunschweig in conjunction with the Fire Department to examine the effects of large fires (greater than 2,000,000 DM) on the building structure. He felt that sufficient survey information will be available in two years to provide a summary.

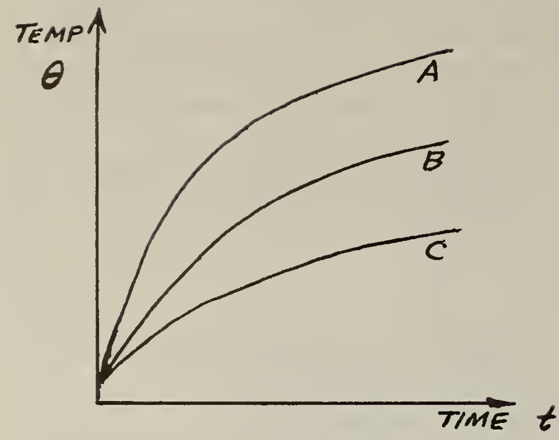
Mention was made of fires in tunnels and associated research in Japan, in Netherlands and in Germany (i.e., a hollow tunnel bridge). Mr. Reichel indicated that based upon the Czechoslovakian review of statistics on building fires over the years 1970 to 1975 the main weakness was found to be failure of a fire door. There was building damage only where a structural overload had occurred or where a basic design error was present. He felt that for prefabricated panels there was insufficient tie-in to the remainder of the structure. Finally, with regard to repairability of structures, he felt that expansions exceeding 10 or 15 centimeters of a steel beam were not repairable.

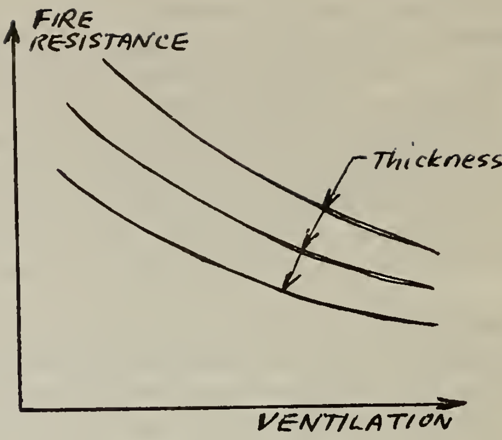
Mr. Papaioannoy indicated the importance for CIB W-14 to provide guidance on practical experience from real fires, from the structural research viewpoint and not the forensic (cause/blame) viewpoint. Prof. Witteveen said it was very difficult since conditions prior to the fire, information on the actions of the fire brigade, and the original building plans and subsequent changes are generally not available. This was supported also by Pettersson and Reichel. Mr. Kalos pointed out the usefulness of having guidelines on repairability after fire. Mention was made by Malhotra of the UK report prepared by the Concrete Association on repairability of concrete structures. Prof. Witteveen suggested that a possible new concept could be proposed, namely, the design of buildings on the basis of repairability after a design fire, rather than on the ultimate load and deformation such as is done at present. But Mr. Keough indicated that in limit state design all buildings may have to be demolished, so the question of repairability is moot. Prof. Pettersson indicated that from the structural point of view, the future task is to calculate residual stresses and the residual state of the structure. In summary, Mr. Malhotra felt that Group I should ask its Code Advisory Panel to consider the need for research and information on repairability of structures following fire.

With regard to the Code Advisory Report Document 78/78, Mr. Malhotra inquired as to how this may be more widely circulated, and hearing no objections, said he would recommend wider circulation through CIB. This report contains principles and guidelines for the preparation of international codes on structural fire protection.

At this stage the floor was opened up for supplementary reports and information on large-scale tests and real fires.

Mr. Reichel pointed out that an unresolved problem was the inability to provide adequate evaluation of the integrity of structural components. Since materials behave differently under different temperature exposure conditions, he offered the suggestion of considering three different temperature-time exposure curves. He noted that with brick walls, there was little difference in behavior even under different temperature exposures and heating rates, but with concrete there is a big difference. Therefore, one should not assume a given behavior particularly with regard to integrity. The suspended ceiling was a notable example. Mr. Reichel offered to prepare a CIB paper on the subject and hopefully





will be able to calculate the effective fire duration from different natural fires (e.g. A, B, C in left sketch). The effective fire resistance can be computed as a function of compartment ventilation and thickness of protection (right sketch). Prof. Pettersson pointed out that this approach was used several years ago by someone in Berlin and the approach was to use $\theta = \theta_o + K \log_{10} (\frac{8t}{A} + 1)$ with values of A chosen to accommodate different materials, e.g., the effect of the charring of wood at different rates vs. temperature.

Dr. Harmathy gave brief discussions of his papers 80/45 "Effect of Nature of Fuel on the Characteristics of Fully Developed Compartment Fires" and 80/44 "The Possibility of Characterizing the Severity of Fires by a Single Parameter." In response to Prof. Pettersson's question, Harmathy indicated that the overall heat load concept was not applicable to unprotected steel structures (or to concrete filled steel columns), but that this approach may be a temporary flash-in-the-pan.

Dr. Haksever discussed his document 80/54 referring to prestressed concrete tubes for a subway and tunnel box bridge construction for a new Reichsbrugge. He found that with protection up to 30 millimeters a potential subway fire will not cause distress, excessive deformation or irreparable damage. Therefore, his recommendation was to apply protection 1/2 meter above the rail. He did not consider explosion or smoke spread although his calculations did include the structural load due to traffic above the tunnel of this combined tunnel-bridge.

Group II. Non-Structural Matters

A. Smoke Control and Emission

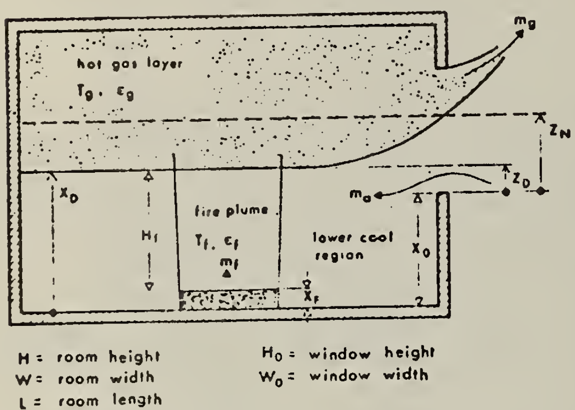
The rapporteur for this topic was Mme. Majou who prepared Document 80/75 (in French). In the area of smoke control, there was an active discussion on the limiting pressure difference for pressurization systems. Mr. Keough indicated that in Australia, 100 Pascals was considered a practical level where there are limited air inlets. He noted that in Sydney there are 200 buildings each with two pressurized stair shafts. Fans were selected on the basis of a high pressure difference and low flow, whereas they should have been based upon a large flow capacity with low Δp. In France, fans of 15,000 to 20,000 cubic meters per hour are used depending upon the leakages around the stairway and exterior wall. Rilling mentioned the U.S./French plan to examine pressure relief methods. It was noted that in Germany and England, the practice is to use a pressure difference of about 50 Pascals. In Germany, tests were made on buildings in Hamburg with a pressure difference between 20 to 30 Pascals. In the fire room, there was a positive pressure of between 30 and 40 Pascals. There was a shaft to exhaust smoke. The pressure difference was reduced to zero when the window broke. Mme. Majou indicated the need to provide both lower and upper limits and suggested 100 Pascals. However, many felt that the lower level can be neglected as long as flow is established. Mr. Yamaguchi mentioned that pressure differences in tall buildings in Japan may reach as high as 200 Pascals and they therefore provide a small smoke leakage flap in such doors. The highest level is limited to 150 Pascals but where children and handicapped persons are present the limit is dropped to 50 Pascals. A suggestion was then made by Mme. Majou to limit the mean air flow velocity over the doorway to 1 meter per second. Dr. Seeger said it was necessary to have 2 to 3 m/sec through a single open door measuring 1 x 2 meters when the temperature is approximately 800°C in the fire room. He referenced a Report No. 35 by John in Karlsruhe dated October 1978.

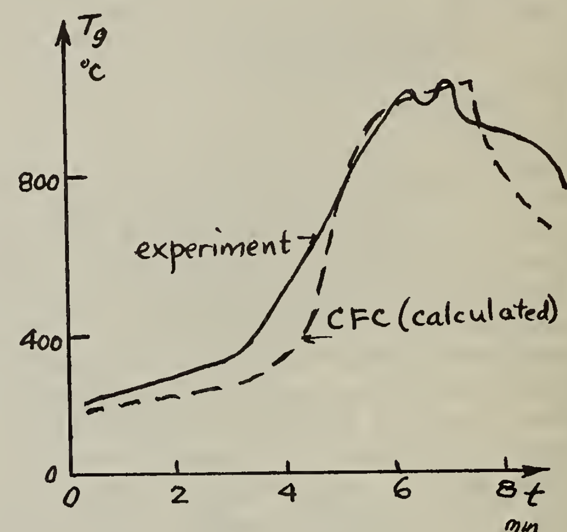
B. Mathematical Modeling

There was active discussion on the subject of Mathematical Modeling of Fire Growth with Dr. Magnusson as rapporteur (Document 80/78). He scoped the problem as including fire growth in enclosures but excluding post-flashover conditions, i.e. it involved microscale fire physics including ignition, flame spread and extinction. He described the quasi-steady state model and extension to the transient condition as described in the FOA report by Hagglund (Document 80/77). He noted the need to coordinate the international development of appropriate test methods for surface flame spread and rate of heat release. For the multiroom situation, the pressure field combinations are considered numerous and difficult. He mentioned that the Harvard model was being changed to include the effect of multiple rooms. He mentioned the Tanaka model involving the conversion of a horizontal door jet to a vertical plume. Mr. Rilling indicated that there is a problem with the mixing of the smoke below the soffit. In the evaluation of the

assumptions, some discussion revolved around the Harvard two-layer model and the attempt to use a linear temperature gradient instead of two layers, but that the results were not as good. It was noted that the recirculation had an effect on mass burning rate in a manner predictable by the model, i.e. $\dot{m}$ decreased when the oxygen level was less than 17%. Mention was also made of the Quintiere analysis involving comparative data from the modified ISO flame spread test.

Hagglund then described the results of some recent calculations of fire growth involving an interactive computer program in which four modes were possible. These were compared with experimental measurements in several rooms (See sketch).





Mr. Shaenman questioned the use and application of these models and the need for CIB W-14 to provide a quotable position on the importance of modeling in order to justify research funding and applications in the near future. Dr. Thomas pointed out that one application was Quintiere's analysis of the ISO Flame Spread Test and the importance of identifying the appropriate property terms such as thermal inertia, B factor, latent heat of vaporization and stoichiometric ratio. There was an active discussion on the relationship between mathematical modeling, the use of models and the importance of standardized test methods. Mr. Becker asked whether there was any advice CIB W-14 can give to product manufacturers in terms of how to improve their products from the standpoint of safety, but no direct reply was possible at this time.

Fire Safety Panel

A meeting of the Fire Safety Panel chaired by Prof. Witteveen was held on May 21. Two reports were distributed: the minutes of the meeting in Sydney, Sept. 7, 1979 and a draft of a work program and proposed workshops on special topics prepared by Erik Pedersen. Following approval of the agenda and a report of activities, there was a discussion of the

interaction of fire prevention measures (passive and active). Mr. Malhotra indicated that there is a change from predominantly property protection to combined life safety plus property protection. Passive protection is provided in the original design and is always present. Active protection is considered to be an add-on and is reactive only in the event of fire. He illustrated this interaction by means of a diagram with arrows between listed active and passive components.

The discussion shifted toward use of design loads and reliability-based design. The approach used by Prof. Pettersson was based on using characteristic structural and fire load values adjusted by using partial factors (probabilities of differences, uncertainties) and reduction factors (relative duration). Thus, the design loadbearing capacity is obtained from the design loads by means of these partial factors. Ms. Kersken-Bradley then provided a discussion of the rational criteria for decisions on the required fire resistance time of structural elements. She indicated that the required fire resistance time depended on 1) risk to human life and losses due to structural failure; 2) the frequency of the fire; and 3) the development of the fire. Since fire is an accidental situation the tolerable losses could be considered in terms of a failure probability which depends upon the consequences of failure. Secondly, the damage due to fire could be modeled by the product of probabilities $p_1 \times p_2 \times p_3$ where p_1 is the mean probability for initial fires occurring per square meter compartment area per year; this is a function of the use of the building, p_2 is the probability that fire fighting forces fail to prevent flashover; and p_3 is the probability that sprinkler systems fail. The resistance of structural components to fire exposure may be accomplished either by determining the equivalent fire duration time, or using a heat balance calculation. This presentation is included in the document entitled "Draft Model Code 'Constructional Fire Protection'" (Document 79/45). In the discussion that followed, Ms. Kersken-Bradley indicated that the model is intended to apply to both life safety and property protection, that these are not considered separately and that they believe they are interpreting the intent of the current German regulations. There were questions raised as to the assumption of the independence of certain probability factors. Mr. Shaenman questioned whether decisions should be made on the basis of relatively fine differences without serious analysis. In this regard sensitivity analysis may be useful. Prof. Witteveen suggested that the Fire Safety Panel accept the problem of evaluation of trade-offs as one of its initial tasks.

Erik Pedersen made a proposal for a 2-day workshop on "trade-offs" but this title was subsequently changed to "Fire Safety Design." The object of this workshop would be to consider fire protection alternatives and it is intended for the most active informed expert individuals (not organizations) on an invitation basis. Prof. Pettersson suggested an exercise in which a blank matrix would be distributed along with a request for suggestions from the participants as to which factors are important in fire safety of two different types of buildings. There was an extensive discussion on the aim of this workshop. Ms. Kersken-Bradley suggested that a draft model code is the ultimate aim, but Gross and

Thomas argued that the aim should be better understanding of how to evaluate trade-offs or alternative safety measures; the generation of a draft code would be outside the scope of CIB W-14 and is premature especially since we have not yet obtained fire safety statements from insurance, fire service, code officials and fire equipment manufacturing segments. Mr. Wilmot offered to be a liaison with the insurance interest, (i.e., CEA) based on his previous long experience in the insurance field. It was suggested that the first day of this two day workshop would involve detailed technical discussions by CIB researchers (Witteveen, Kersken-Bradley, Wilmot, Pettersson, Rasbash, CFR/Gross) and the second day for a broader discussion in a combined meeting involving code, insurance and fire brigade interests.

Fire Statistics

There were two major presentations on fire statistics by Tom Wilmot of Sussex University and Phil Shaenman of the U.S. Fire Administration. Also Dr. Kovacs made a brief summary of the replies to his questionnaire circulated to recommended experts.

Mr. Wilmot conducted a three year research project on European fire costs sponsored by the Geneva Association from 1975 to 1978. Paper No. 80/64 "European Fire Costs - the Wasteful Statistical Gap" separated fire costs into seven specific items. For the 12 European countries studied, he found that fire costs were running at the rate of approximately 1% of the gross national product and that these costs were divided approximately as follows: direct losses 30%, building protection 30%, fire brigades 15%, fire insurance 15%, indirect losses 5% and human losses 5%. The cost of the seventh item, Fire Research and Propaganda, was negligible. He mentioned that the fire losses published by NFPA for European countries were incomplete since government losses were excluded and usually all uninsured losses were omitted. Therefore, Wilmot's figures were based on insurance claims paid by fire insurance companies operating in various countries with adjustments made to allow for losses not insured such as government properties (add 3%), losses uninsured or subject to excesses (add 7.5%) and fires on ships or in cars (add 4.5%). In some cases deductions were made for indirect losses paid. His summary table for European Direct Fire Losses showed that these losses range from 0.15 to 0.53% of the gross domestic product (the lowest in Italy and highest in Luxembourg). While Wilmot found that the direct fire losses were generally higher than values quoted, he found that the indirect fire losses were generally not as high as generally stated ("3 times direct losses"). Indirect losses were defined as losses affecting the overall national economy as a result of consequential fire losses, rather than individuals suffering losses. In calculating these, Wilmot estimated that only 50% of the actual indirect losses affected the national economy, the balance being taken up by gains to trade competitors, etc. He found that the ratio of the indirect fire loss to direct fire loss in the six European countries ranged from 15% to 32% which is an order of magnitude less than the usually accepted figure. Other attendees also confirmed that indirect fire losses were only a fraction, roughly 1/3, of

direct fire losses. With regard to human losses, Wilmot found that these were generally underestimated since they are usually provided by fire departments and unreported deaths may be as much as 50% higher (as reported in a Dutch study). Wilmot used a published figure for the economic value of a life saved by fire, that given by Melinek of £50,000 for a life and £1,000 for a fire injury based on 1972 figures ("Loss of Life Expectancy Due to Fire" by S. J. Melinek, Fire Research Station). The range of fire deaths per 100,000 population during the period 1970 to 1975 ranged from 0.61 in Switzerland to 2.35 in Finland with a mean of 1.57. Mr. Wilmot went on to compare the costs for fire brigades, for fire insurance administration, and for providing fire protection for buildings in the European countries. He stated that the fire protection cost averaged approximately 2.5% of the building cost varying from 1% for housing to 7% for industry. Wilmot's basic conclusion was that fire is costing most countries approximately 1% of the gross domestic product and yet no European country appears to be producing annual fire cost statistics. Furthermore, if worldwide fire costs are to be controlled, then national governments will need to start two essential bodies: 1) an effective national statistical bureau covering the seven items of fire cost, and 2) a national fire prevention organization responsible for coordinating the efforts of existing fire prevention agencies. I also received from Mr. Wilmot the original document of the same title published in April 1979 by the Association Internationale Pour l'Etude de l'Economie de l'Assurance (i.e. the Geneva Association) Etudes et Dossiers No. 27.

In the discussion session, Mr. Malhotra questioned why we as a group have been under the impression that indirect losses were so much larger. Tom Wilmot answered that this was probably due to haphazard propaganda by insurance interests who offer to sell more protection, and by fire equipment manufacturers who sell equipment to prevent "potential losses due to loss of business profits and mission discontinuity." Several countries felt that the quoted statistics on human loss for their country were incorrect, e.g., Netherlands and Germany felt the figures quoted by Wilmot were two times the true figure.

Mr. Shaenman provided an extensive discussion of the current status of fire loss statistics in the U.S. and in the world. He made comparisons of fire deaths per capita, building fires per capita, dollar loss per fire, deaths per fire, loss as a percent of GNP, and the composition of the fire problem in terms of the degree to which it is residential, non-residential, exterior fires, etc., and also for a few countries the principal causes of fires and deaths. He indicated several problems which prevent us from making additional international comparisons of fire statistics, and suggested that a standard report form, either the U.K. form or that proposed in the U.S.A. working paper (Tovey for ISO TC 38/SC 19), be circulated to the various member nations. The form contains certain key elements, including: classification of the building, source of ignition, origin of fire, material first ignited, occupancy type, etc. It was agreed that Kovacs, Thomas and Wilmot will prepare a formal request to be sent to UN/ECE for circulation to member countries and other inter-governmental agencies, requesting them to use the forms and to report the

data. CIB W-14 would like to be the data collector rather than the data user and the need for an international data center was stressed. Shaenman questioned whether UN/ECE would be able to financially support either partially or totally such an international data collection scheme but there was no clear answer as to whether delegates thought this was possible. Mr. Wilmot felt that ECE was interested in the views of CIB but that the potential funding probably requires individual government resolutions of support. He stated that initially there will be a status report by ECE this year and if wide support becomes evident some future funding is possible.

Mr. Shaenman indicated that the comparisons between countries are not necessarily the same within countries. He indicated that in the U.S. there was an increase in the fire death trend from 1975 to 1978 (based on death certificates) possibly due to colder winters, increased use of insulation and use of wood burning heating devices and despite the increased use of smoke detectors. He made comparisons by states, by counties, by community size, by cities, by race, and by sex. He announced that the computer software was available to all countries and that Australia and New Zealand will soon be using the USFA computer software. Draft copies of the USFA publication "Fire in the U.S." and its list of publications were made available. Shaenman was seeking support from CIB and other organizations to provide encouragement in collecting world wide fire statistics.

In the discussion period, Mr. Keough questioned the overall reliability of statistics and suggested that unless the source of data is critically questioned the data should not be accepted on full face value. There were several questions on cost benefit, that is, whether it is beneficial to spend money on education and fire prevention vs. technology and Mr. Shaenman felt that in the short term fire prevention education was more cost effective. It was generally agreed that an analysis of every fire by the Fire Department is not practical but that a simple one page summary of all fires would be helpful. In addition, a specialized random survey of particular problems would be useful. In response to a question by Prof. Twilt, Shaenman indicated that he had found no relationship between fire deaths and the structural integrity of the building in which the fire death(s) occurred.

Fire Protection Education

Prof. Olesen from the University of Aalborg had prepared a Document 80/71 dealing with Fire Technology and Fire Engineering in Universities. This is an update of a report which he prepared two years previously. In this report he classifies the instruction at the various universities in terms of six levels as indicated in the following table.

Level			Typical Instruction
0	Introductory Level	0-5 hrs	Basic mention of fire/ combustion problem
1	Elementary	5-20 hrs	Fire aspects/classification/ codes/sprinklers
2	Basic Scientific	20-60 hrs	Fire technology
3	Advanced	60-300 hrs	Thorough course
4	Specialization	>300 hrs	Special tasks (theoretical or lab)
5	Research	1-2 yrs	Post-Graduate

He identified some universities which provided fire engineering education at various levels 1, 2, 3, 4 and 5. He indicated that the main problem was that many students graduate without a basic understanding of fire technology and therefore it is difficult to transfer research results into practice. His suggestion was to continue circulation and distribution of information which he had gathered on fire engineering education and that individuals from member bodies should encourage increased application of the educational opportunities in their countries.

In the discussion period, Dr. Schaffer mentioned the ASCE Committee on Full-Scale Structures and Prof. deCicco's role in formulating an education module on fire protection. He also mentioned that at Forest Products Laboratory they have made grants for one hour workshops to develop introductory courses or modules for distribution to other colleges.
Mr. Floros, a Greek architect involved with the committee writing the building code for the Technical Chamber of Greece, noted that it was necessary to provide basic principles in a simple way when these courses are taught as part of other curricula such as architecture.
Mr. Papaioannoy indicated that in Thessaloniki teachers were engaged mainly in other fields such as building construction or civil engineering and had no direct contact or association with fire protection.
Prof. Olesen indicated that his survey had not determined whether the teachers listed in his survey as teaching fire engineering courses were in fact involved mainly in a different department at the University.
Prof. Pettersson suggested the possibility of creating a small group in CIB to coordinate the development of a text book with contributions to be received from University staff in different countries who are willing and able to participate. The principal proposal was offered by Prof. Olesen who suggested an informal workshop on fire engineering education next year in Denmark. This could be a prelude to a possible future symposium or conference on fire engineering education and one topic that may be discussed at the workshop is the feasibility of the text book suggested by Pettersson. A copy of Prof. Olesen's report on "Fire Engineering Education World Wide 1980" will be circulated to CIB W-14 members and to those Universities which have replied to the questionnaire. Although Olesen's report will not be distributed widely, an announcement may be made in the CIB house Journal for any interested readers.

Group I Summary Report

Mr. Malhotra indicated that there were 30 participants discussing nearly 40 papers over a period of 1 1/2 days with discussions being by rapporteurs and by individual participants. The four main topics discussed will be prepared in written form by the rapporteurs and made available to CIB W-14 members. With regard to the measurement of the properties of materials and the use of calculation rules, Malhotra indicated there was an imbalance in efforts on calculations of structural behavior and material property data. There is some activity in RILEM and Group I supports more effort devoted to developing suitable property data. With regard to analytical methods there is an increased trend toward the use of analytical methods and on design guides based on them. With regard to the draft German code transmitted for comment by ISO, more work needs to be done to validate the model but in general the approach appears commendable. With regard to large-scale fires it was felt that there was no need to produce a document on standardization of full-scale tests since this is being undertaken in ISO TC92. Consideration should be given to test series ranging from a relatively small number of tests, to an extensive series, e.g., the Lehrte series. It was felt that large-scale tests should have a structural bias. Also, the question of the repairability of structure following fire may be important and the Code Advisory Panel should be asked to study the problem and prepare a state-of-the-art report for the next meeting.

In the discussion period, the question was raised as to why the Code Advisory Panel should consider repairability of structures and large-scale fires. It appears as if the name "Code Advisory Panel" may not be appropriate. Concern was expressed about the overlap between CIB W-14 and ISO TC92 on the subject of large-scale fires. I questioned this concern since I felt that ASTM E 603 was not overly concerned with structural factors and that there had been no discussion of this in WG 11. However, Thomas, Malhotra and Pettersson said that in their view E 603 did include structural factors and the topic of large-scale fire tests was included in WG 7 and will be transmitted to Subcommittee 2. With regard to publications, it was indicated that the Document 78/81 of Law and Pettersson had still not been prepared in final form but the information would be included eventually. With regard to Document 78/78 this was going to be submitted for publication with no problems foreseen. With regard to documents which arise from the common activities of CIB W-14, i.e. rapporteurs reports, these deserve to be issued separately by CIB.

Group II Report on Non-Structural Matters

Mr. Becker indicated that there were two major tasks in the area of smoke. For smoke control, Mme. Majou was the rapporteur and she requested member comments on Document 80/75, so she can prepare a revision to be published as a CIB publication. Secondly, on the basis of the above paper, general recommendations or guidelines will be made to engineers and architects regarding pressurization and other smoke control systems. An ad hoc group consisting of Majou, Gross, Heselden, Keough, Rilling, Seeger, Twilt and Wakamatsu will be responsible for reviewing this publication.

On the subject of smoke emission, Document 80/76 (yet to be distributed), was also prepared by Majou as rapporteur. This summarized the parameters of smoke measurements including opacity, test reproducibility, comparisons with room tests, effects of moisture, etc. The conclusion was that smoke emission depends partly on material properties and partly on systems factors. A complete bibliography will be prepared with the interim report. The same group plus Mr. Twilt will be involved in this activity with Rasbash, Thomas and Becker as corresponding members. This activity does not include the topics of toxicity, signaling systems and exiting requirements.

The other topic covered in the Group II discussion was mathematical modeling (fire growth experiments were folded into this topic and not discussed separately). This was summarized by Magnusson as rapporteur in Document 80/78 which pointed out the differences between the many different models available, their applicability and correlation with general fire growth, and their influence on test design and test development. It was also mentioned that input data to the model from laboratory tests, e.g. ignitability, flame spread and rate of heat release are required. The Quintiere model was referenced and in particular the need for preheating in a lab test in order to model properly was mentioned. More sensitivity studies are needed. The increased interest throughout the world in the entire problem of mathematical modeling was noted. The particular work of Mr. Rilling on modeling at CSTB was noted as was the work of Wickstrom in validating calculations by test using both gas fires and furnishings. It was noted that this could be a resource on validation for Subcommittee 1 of ISO TC 92. Mention was made of the Jakobsen's survey of students' work on the fire performance of wall linings.

With regard to handling of documents, it was stated that following approval of a given document, it will be circulated to all CIB Commissions (including heating and ventilating) and must be approved by the individual Commissions and by the CIB board. Finally, a workshop meeting on modeling is to be organized and held in Europe and furthermore Magnusson, with help from Rilling, will prepare an improved document on the subject of fire growth and mathematical modeling for publication.

The overall question of document circulation in CIB W-14 was discussed. It was decided to prune the mailing list by eliminating members who had not answered any letters in the last three years. However, these members may be sent certain selected documents. As examples of such non-contributing members were mentioned Austria, Turkey, India, Brazil, Romania, Spain (2 at separate addresses) and the Boucentrum in the Netherlands. There was a discussion on creating a classification of documents by priority and to use three separate numbering systems to differentiate between documents directly connected with the work program, those not connected with the work program and documents which originate within the commission rather than by individual participants. In response to Mr. Becker's question, Dr. Thomas indicated that it would be possible to circulate the Table of Contents of the CIB house Journal (Building Research and Practice) so that CIB W-14 members will be aware of these articles. Previous articles had been prepared by Dr. Thomas and by Mr. Malhotra, the latter on the work of the Code Advisory Panel. Mr. Malhotra suggested circulation of one or two line summaries of paper contents since the title sometimes is insufficient. Dr. Thomas agreed to consider a (letter) classification system by categories so that the originating Member Body organization may be able to assign one or more letters to its publications directly.

Work Program

With regard to the overall CIB W-14 work program, it was indicated that the exchange of information and the work program were the central items of concern to CIB. Convenors, rapporteurs and chairman should get together with Dr. Thomas in order to define the work program and its limits.

Fire Safety Statements

One of the last activities was a discussion of fire safety statements as part of the work of the Fire Safety Panel. The original request for advice on the subject came from ECE and ISO. I was asked to start the discussion and I illustrated some differences between the stated position of one interest group, i.e. insurance underwriters, vs. my own personal concept of the aims of fire safety for this group. There was an active discussion on (a) the limited progress over the last two years, and (b) whether the development of these statements should be undertaken before more defined boundaries and design applications are provided by the requesting agency, (the ECE Joint Committee on Structural Safety). Dr. Thomas requested D. Gross to contact Mr. Wilmot and Mr. Wessels to get input on the insurance point of view. Also a structured questionnaire is obviously necessary to get suitable response from the different interest groups. Mr. Erik Pedersen has worked out a matrix questionnaire and he will make this available so that the necessary inquiries can be started with the objective of assembling comments and possible concensus opinion before too long.

Future Arrangements

The following plans were formulated for workshops:

1. The Fire Safety Panel will plan a workshop on "Fire Safety Design" including fire protection alternatives/trade-offs; the meeting, probably in Germany in December 1980 or January 1981, is intended for the most active informed experts and may lead to a future symposium. Although the proposed "Draft Model Code" will not be the starting point, it will likely be an important reference document. The U.S. and other member bodies indicated their willingness to participate.

2. A workshop on "Fire Engineering Education" is planned for Denmark in Spring 1981. This will also be a limited participation two-day meeting which could result in (a) a future symposium or conference, and (b) a plan for a fire engineering text book.

3. A workshop on "Modeling of Fires," which was a very active discussion item, is planned for Spring of 1981. The possible sites are Lund, Paris or Ludwigshaven with invitations limited to active informed experts. Again the U.S. and other countries expressed willingness to participate in such a workshop.

Finally, the next Plenary Meeting scheduled for 1982 will take place in the Netherlands at the kind invitation of Prof. Witteveen. Exact location (Amsterdam, Delft or Hague) is yet to be determined.

Appendix A

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Appendix B

LIST OF PAPERS CIRCULATED TO DELEGATES
SINCE THE 13th MEETING

1978

CIB W14/78/80 (S)	Fire Safety in Buildings: Needs and Criteria. CIB Proceedings - Publication 48.
CIB W14/78/81 (UK)	Draft Recommendation - The Basis of Design for the Fire Protection of Building Structures. By M. Law and Ove Pettersson.
CIB W14/78/82 (D)	Fire Engineering Education 1978. A preliminary survey on University Educational Activities within fire technology and fire engineering. May 1978 - Report No. 7802. By Frits Bolonius Olesen.
CIB W14/78/83 (F)	Controle des fumes dans les batiments. By A. M. Majou (Draft report).
CIB W14/78/84 (D)	Part I Testing Facilities at the AUC Fire Research Laboratory March 1978 - Report No. 7801. By N. J. Hviid and F. B. Olesen.
CIB W14/78/85 (N)	Report to CIB W14 General Meeting - Liaison CIB-CTIF-CEA. By Prof. ir J. Witteveen.
CIB W14/78/86 (S)	Structural Fire Protection. Lund University Bulletin 60. By O. Pettersson.
CIB W14/78/87 (S)	Functional Approaches - An Outline. Lund University Bulletin 62. By O. Pettersson and S. E. Magnusson.
CIB W14/78/88 (S)	Some Results from an Analysis of Industrial Fires in Sweden. Swedish Institute of Steel Construction. By J. Thor and G. Sedin.
CIB W14/78/89 (S)	Basic Information from an Investigation of Industrial Fires. Swedish Institute of Steel Construction. By G. Sedin and J. Thor.
CIB W14/78/90 (UK)	Collected Summaries of Fire Research Notes and BRE/FRS Current Papers 1977 (also 79/22). By L. C. Fowler.
CIB W14/78/91 (J)	Proceedings of 2nd Joint Panel Meeting of the U.J.N.R. Panel on Fire Research and Safety, 19-22 October 1976, at Tokyo, Part 1 (General Report), Building Research Institute.
CIB W14/78/92 (J)	Proceedings of 2nd Joint Panel Meeting of the U.J.N.R. Panel on Fire Research and Safety, 19-22 October 1976, at Tokyo, Part 2 (Minutes and Discussions), Building Research Institute.

1979

CIB W14/79/1 (F) Fire Behavior of Pipe Wall-Crossing (Penetrations) Compte Rendu D'Essai (in French), UTI/CTICM.
By D. Cluzel and P. Arnault.

CIB W14/79/2 (UK) A Review of Data on Active Methods of Fire Protection in Residential Premises: Experimental Fires, BRE CP 21/78.
By P. Shakeshaft.

CIB W14/79/3 (UK) A Study of the Operation and Effectiveness of Fire Detectors Installed in the Bedrooms and Corridors of Residential Institutions, BRE CP 26/75.
By R. H. Kennedy, K. W. P. Riley and S. P. Rogers.

CIB W14/79/4 (UK) The Ignition and Burning Characteristics of Fabric Covered Foams, BRE CP 30/78.
By W. D. Wooley, S. A. Ames, A. I. Pitt and K. Buckland.

CIB W14/79/5 (UK) Growth and Development of Fire in Industrial Buildings, BRE CP 40/78.
By C. R. Theobald.

CIB W14/79/6 (UK) The Ventilation Required to Permit Growth of a Room Fire, BRE CP 41/78.
By M. L. Bullen.

CIB W14/79/7 (UK) Life Safety: What Is It and How Much Is It Worth?, BRE CP 52/78.
By C. H. Green and R. Brown.

CIB W14/79/8 (UK) Studies of Fire and Smoke Behaviour Relevant to Tunnels, BRE CP 66/78.
By A. J. M. Heselden.

CIB W14/79/9 (UK) A Computer Model for Analysing Smoke Movement in Buildings, BRE CP 69/78.
By E. Evers and A. Waterhouse.

CIB W14/79/10 (UK) Fires in Dwellings - An Investigation of Actual Fires, Part II: Hazards from Ground-Floor Fires, Part III: Physiological Effects of Fire, BRE CP 80/79.
By A. Silcock, D. Robinson and N. P. Savage.

CIB W14/79/11 (CD) Bau- und Wohnforschung, Fire Research in Lehrte, University of Braunschweig.
By Prof. K. Kordina.

CIB W14/79/12 (CA) A Test to Grade Horizontal Flame Spread, Tech. Record 447. (Use of proposed ISO ignitability test for measuring initial flame spread on textiles.)
By A. W. Moulen, S. J. Grubits and P. A. Miles.

CIB W14/79/13 (D) Rauch- und Warmeabzug in Gebauden (in German) (Review of Literature Dealing with DIN 18230), University of Braunschweig.
By Dr. U. Schneider.

CIB W14/79/14 (D)	Untersuchung des Verbundverhaltens und der Verbundfestigkeit von Rippenstaben und Glatten Rundstabenbei Hohen Temperaturen (Entwicklung und Erprobung einer Prufapparatur) (in German) Behavior and Strength of Ribbed and Smooth Reinforcing Bars at High Temperatures, University of Braunschweig. By U. Schneider and U. Diederichs.
CIB W14/79/15 (D)	Ein Beitrag zur Frage des Kriechens und der Relaxation von Beton unter hohen Temperaturen. By von Ulrich Schneider.
CIB W14/79/16 (UK)	Report of the Thirteenth Meeting of CIB Commission W14 Technical University of Denmark - Lyngby - Denmark 29th May to 2 June 1978. (Complete report of commission meeting - 28 pages and appendix.)
CIB W14/79/17 (D)	Physikalisch-Chemische Analyse Sowie Toxische Beurteilung der beim Thermischen Zerfall Organisch-Chemischer Baustoffe Entstehenden Brandgase (in German) Part 1.
CIB W14/79/18 (D)	Physikalisch-Chemische Analyse Sowie Toxische Beurteilung der beim Thermischen Zerfall Organisch-Chemischer Baustoffe Entstehenden Brandgase (in German) Part II. Physical-Chemical Analysis of Toxic Nature of Thermal Decomposition Products of Organic Building Materials - A Literature Review, BAM. By Dr. D. Rennoch.
CIB W14/79/19 (C)	Relationship Between Fire Resistance & Fire Tolerance. By T. Z. Harmathy. (Short technical review of three methods for designing for fire resistance requirements, 9 pages.)
CIB W14/79/20 (D)	Research Report on the Fire Behaviour of Glued Laminated Timber Stauchions of Rectangular Cross-Section. By Dr.-Ing. A. Haksever. (Technical report of behaviour in furnace. 70pp in German.)
CIB W14/79/21 (D)	Research Report on Fire Behaviour of Glued Laminated Timber Stauchions of Cruciform Cross-Section. By Dr.-Ing. A. Haksever.
CIB W14/79/22 (UK)	Collected Summaries of Fire Research Notes and BRE/FRS Current Papers 1977 (also 78/90), BRE. By L. C. Fowler.
CIB W14/79/23 (UK)	Collected Summaries of Fire Research Notes and BRE/FRS Current Papers 1978, BRE. By L. C. Fowler.
CIB W14/79/24 (J)	Inelastic Behavior of Protected Steel Beams and Frames in Fire, Tokyo Institute of Technology, Research Lab of Engineering Materials 3. By F. Furumura and Y. Shinohara.

CIB W14/79/25 (J)	Primary Creep of Structural Steel at High Temperatures, Tokyo Institute of Technology Research Lab of Engineering Materials 4. By Fujimoto, Furumura, Ave and Shinohera.
CIB W14/79/26 (C)	Design to Cope with Fully Developed Fires. By T. Z. Harmathy. (Design of fire resisting structures by enquiring methods [called here fire tolerance] and comparison with test methodology, 76 pages, 178 references.)
CIB W14/79/27 (UK)	Compartment Fires with Non-Cellulosic Fuels, (also 79/43), Combustion Symposium. By M. L. Bullen and P. H. Thomas.
CIB W14/79/28 (J)	Bulletin of Japanese Association of Fire Science and Engineering, Vol. 28, No. 1, 1978 (in Japanese).
CIB W14/79/29 (J)	Bulletin of Japanese Association of Fire Science and Engineering, Vol. 28, No. 2, 1978 (in Japanese).
CIB W14/79/30 (J)	Studies of Probabilistic Spread of Fire, BRI Research Paper 80. By Y. Aoki.
CIB W14/79/31 (J)	Experimental Study of Compartment Fires Using Model Boxes, BRI Research Paper 81. By F. Saito.
CIB W14/79/32 (J)	Flashover Criteria of Compartment Fire (Theory on Zero Order Reaction System), BRI Research Paper 83. By Y. Hasemi.
CIB W14/79/33 (S)	Reducing Life Hazards Due to Fire - A Governmental Investigation, Lund University Bulletin 63. By S. E. Magnusson.
CIB W14/79/34 (S)	Behavior and Analytical Design of Fire Exposed Steel Structures, Insulated with Gypsum Plaster Slabs, Lund University Bulletin 64. By O. Pettersson.
CIB W14/79/35 (S)	Analytical Design of Fire Exposed Concrete Structures, Lund University Bulletin 65. By Anderberg, et. al.
CIB W14/79/36 (S)	Thermoplastic Pool Compartment Fires, Lund University Report No. 79-1. By V. Babrauskas and U. Wickstrom.
CIB W14/79/37 (S)	TASEF-2 - A Computer Program for Temperature Analysis of Structures Exposed to Fire, Lund University Report No. 79-2. By U. Wickstrom.
CIB W14/79/38 (S)	A Numerical Procedure for Calculating Temperature in Hollow Structures Exposed to Fire, Lund University Report No. 79-3. By U. Wickstrom.
CIB W14/79/39 (S)	Temperature Analysis of Compartment Fires and Fire-Exposed Structures, Lund University Report No. 79-4. By U. Wickstrom.

CIB W14/79/40 (S)	Structural Design of Fire Exposed Rectangular Laminated Wood Beams with Respect to Lateral Buckling, Lund University Report No. 79-5. By Bertil Fredlund.
CIB W14/79/41 (S)	Brandteknisk Dimensionering-principer, underlag, exempel. (To be translated into English.) By Ove Pettersson - Kai Odeen.
CIB W14/79/42 (USA)	Flashover and Instabilities in Fire Behavior. By P. H. Thomas, M. L. Bullen, J. G. Quintiere and B. J. McCaffrey.
CIB W14/79/43 (UK)	Compartment Fires with Non-Cellulosic Fuels (also 79/27), Combustion Symposium. By M. C. Bullen and P. H. Thomas.
CIB W14/79/44 (UK)	Testing Products and Materials for Their Contribution to Flashover in Rooms. By P. H. Thomas.
CIB W14/79/45 (D)	Draft Model Code "Structural Fire Protection".
CIB W14/79/46 (UK)	Smoke Control Methods in Enclosed Shopping Complexes of One or More Storeys: A Design Summary. By H. P. Morgan.
CIB W14/79/47 (USA)	Fire Research and Safety (3rd Joint UJNR Panel), NBS Special Publication 540.

CIB W14/80/1	(UK)	Report of the Code Advisory Panel.
CIB W14/80/2	(C)	Ventilation of Fully-Developed Compartment Fires, Combustion and Flame, 37, p. 25-39. By T. Z. Harmathy.
CIB W14/80/3	(NL)	An Introduction to the European Recommendations for the Design of Steel Structures Exposed to the Standard Fire (CIB/Tsukuba Symposium). By J. Witteveen.
CIB W14/80/4	(NL)	European Recommendations for the Design of Steel Structures Exposed to the Standard Fire European Convention for Constructional Steelwork Committee 3 - Fire Safety of Steel Structures.
CIB W14/80/5	(UK)	Fire Costs - Past, Present and Future Knowledge.
CIB W14/80/6	(UK)	Large Size Fire Simulation Tests. By H. L. Malhotra.
CIB W14/80/7	(USA)	"Decision Analysis of Strategies for Reducing Upholstered Furniture Fire Losses", NBS TN 1101. By S. B. Helzer, B. Buchbinder and F. L. Offensend.
CIB W14/80/8	(USA)	"Assessment of Fire Hazards from Furniture". By S. Davis.
CIB W14/80/9	(USA)	"A Firesafety Evaluation System for Health Care Facilities". By I. A. Benjamin.
CIB W14/80/10	(USA)	"Fire Safety Guidelines for Vehicles in a Downtown People Mover System", NBSIR 78-1586. By R. D. Peacock.
CIB W14/80/11	(USA)	"A Review of Fire Incidents, Model Building Codes and Standards Related to Wood-Burning Appliances", NBSIR 79-1731. By R. D. Peacock.
CIB W14/80/12	(USA)	"Full-Scale Fire Tests with Automatic Sprinklers in a Patient Room", NBSIR 79-1749. By J. G. O'Neill, and W. D. Hayes, Jr.
CIB W14/80/13	(USA)	"Stairwell Pressurization Systems", NBSIR 79-1747. By I. A. Benjamin and J. H. Klote.
CIB W14/80/14	(USA)	"Experimental and Theoretical Analysis of Quasi-Steady Small-Scale Enclosure Fires". By J. G. Quintiere, B. J. McCaffrey and K. BenBraven.
CIB W14/80/15	(USA)	"Some Theoretical Aspects of Fire Induced Flows Through Doorways in a Room-Corridor Scale Model", NBSIR 78-1512. By J. G. Quintiere and K. DenBraven.

CIB W14/80/16 (USA) "Mathematical Fire Modeling".
By R. S. Levine.

CIB W14/80/17 (USA) "Heat Release Rates in Fires".
By A. Tewarson.

CIB W14/80/18 (USA) "An Instrument to Evalute Installed Smoke Detectors", NBSIR 78-1430.
By T. G. K. Lee.

CIB W14/80/19 (USA) "Arousal from Sleep by Emergency Alarms: Implications from the Scientific Literature", NBSIR 78-1484.
By V. J. Pezoldt and H. P. Van Cott.

CIB W14/80/20 (USA) "Time Delay Correction for Heat Release Rate Data".
By D. D. Evans and L. H. Breden.

CIB W14/80/21 (USA) "Experimental Observation of Radiative Ignition Mechanisms", Combustion and Flame 34, 231-244 (1979).
By T. Kashiwagi.

CIB W14/80/22 (USA) "Smoldering Combustion of Wood Fibers: Cause and Prevention".
By R. J. McCarter.

CIB W14/80/23 (USA) "Tests on the Performance of Automatic Fire Detectors in Health Care Occupancies--A Preliminary Report", NBSIR 79-1739.
By R. W. Bukowsi.

CIB W14/80/24 (USA) "Full-Scale Burning Behavior of Curtains and Draperies", NBSIR 78-1448.
By L. D. Moore.

CIB W14/80/25 (USA) "Fire-Safe Structural Steel - A Design Guide", American Iron and Steel Institute, 1979.

CIB W14/80/26 (USA) "Second Moment Reliability Analysis of Fire Exposed Wood Joist Floor Assemblies", Fire and Materials p. 151-155, 1979.
By F. Woeste and E. L. Schaffer.

CIB W14/80/27 (USA) "Smolder Initiation in Cellulosics Under Prolonged Low-Level Heating", (In press: Fire Technology, Feb. 1980).
By E. L. Schaffer.

CIB W14/80/28 (USA) "Room Corner-Wall Fire Tests of Some Structural Sandwich Panels and Components", Journal of Fire & Flammability 10(9):46, 1978.
By C. A. Holmes.

CIB W14/80/29 (USA) "Application of CMA Program to Wood Charring", Fire Technology 14(4):279-290, 296, 1978.
By R. H. White and E. L. Schaffer.

CIB W14/80/30 (USA) "Oxygen Index Evaluation of Fire-Retardant-Treated Wood", Wood Science 12(2):113-121, 1979.
By R. H. White.

CIB W14/80/31 (USA) "Evaluation of Load-Bearing Honeycomb Core Sandwich Panels", Technical Report D-75, 1976.
By B. H. Wendler and E. J. Worrel.

CIB W14/80/32 (USA) "Fire Response of Reinforced Concrete Slabs", J. of the Structural Div., Aug. 1979.
By Z. Nizamuddin and B. Bresler.

CIB W14/80/35 (USA) "The Role of Water in Suppression of Fire: A Review".
By G. Heskestad.

CIB W14/80/36 (USA) "The Influence of Oxygen Concentration of Fuel Parameters for Fire Modeling".
By A. Tewarson, J. L. Lee and R. F. Pion.

CIB W14/80/37 (S) HSLAB - An Interactive Program for Onedimensional Heat Flow Problems.
By Leif Abrahamsson, Bengt Hagglund and Krister Janzon.

CIB W14/80/38 (S) Calculating the Temperature in Fire Exposed Shelters.
By Bengt Hagglund and Rolf Jansson.

CIB W14/80/39 (J) Evaluation of Fire Safety in Buildings, Occasional Report of Japanese Association to Fire Science and Engineering No. 3, 1979.
By Nihon Kasaigakkai.

CIB W14/80/40 (CA) Measurement of Thermal Diffusivity of Masonry.
By P. A. Miles and S. J. Grubits.

CIB W14/80/41 (CA) Australian Monetary Fire Losses.
By J. H. Keough.

CIB W14/80/42 (S) Fire Risk Evaluation and Cost Benefit of Fire Protective Measures in Industrial Buildings.
By Jorgen Thor and Gosta Sedin.

CIB W14/80/43 (J) Smoke Control Design for Shinjuku Nomura Bldg.

CIB W14/80/44 (C) The Possibility of Characterizing the Severity of Fires by a Single Parameter.
By T. Z. Harmathy.

CIB W14/80/45 (C) Effect of the Nature of Fuel on the Characteristics of Fully Developed Compartment Fires.
By T. Z. Harmathy.

CIB W14/80/46 (D) Behaviour of Structural Members and Buildings in Fire Case.
By O. Prof. Dr.-Ing Karl Kordina.

CIB W14/80/47 (D) Ultimate Load Bearing Analysis of Structural Members in Fire Case.
By Dr.-Ing Wolfram Klingsch.

CIB W14/80/48 (D)	Fire Response of Laminated Rectangular Wood Columns with Respect to Buckling. By Dr.-Ing Ataman Haksever and Dr.-Ing Claus Meyer-Ottens.
CIB W14/80/49 (D)	Ein Beitrag Zur Klarung des Kriechens und der Relaxation von Beton Unter Instationarer Temperatureinwirkung. By Dr.-Ing Ulrich Schenider.
CIB W14/80/50 (D)	Feuerwiderstandsdauer Undekleideter Hoher Rechteckbalken aus Brettschichtholz. By Dr.-Ing Claus Meyer-Ottens.
CIB W14/80/51 (D)	Fire Resistance of Composite Concrete-Steel Columns. By Dr.-Ing Wolfram Klingsch.
CIB W14/80/52 (D)	Die Feuerwiderstandsdauer von Bauteilen bei Naturlichen Branden Zusammenhange Zwischen Naturlichen Branden und dem Normbrand. By Dr.-Ing Reinhold Dobbernack, Dr.-Ing Frank Hoffmann and Dr.-Ing Gunter von der Kammer.
CIB W14/80/53 (D)	Investigations on the Shear Behaviour of Reinforced Concrete Beams Exposed to Fire. By Dipl.-Ing. Lore Krampf.
CIB W14/80/54 (D)	The Fire Engineering Design of the New "Reichsbrucke" in Vienna. By A. Haksever and K. Kordina.
CIB W14/80/55 (D)	The Calculation of Post Flashover Fires in Small and Large Buildings, (in German). By Ulrich Schneider and Aysen Haksever.
CIB W14/80/56 (CA)	EBS. Technical Record 453. Fire Detection in a Typcial Cottage. By P. Johnson and A. W. Moulen.
CIB W14/80/57 (USA)	Cooling of Room Fires by Sprinkler Spray. By H. C. Kung.
CIB W14/80/58 (USA)	Calculation of Large-Scale Flow Fields Induced by Droplet Sprays. By Alpert and Mathews.
CIB W14/80/59 (USA)	Fire Radiation - A Review. By J. deRis.
CIB W14/80/61 (F)	"Developpement du feu de Compartiment - Contribution des Revetements et Habillages Combustibles des Murs" (in French). By B. Hognon.
CIB W14/80/62 (F)	"Combustion des Materiaux et Securite au Feu" (in French). By B. Hognon.
CIB W14/80/63 (NL)	Report of Activity of the Fire Safety Panel.
CIB W14/80/64 (UK)	European Fire Costs - The Wasteful Statistical Gap, Geneva Papers No. 13, October 1979. By T. Wilmot.

CIB W14/80/65 (UK) Statistical Methods in Risk Evaluation, Fire Safety Journal, 2, pp 125-145.
By G. Ramachandran.

CIB W14/80/66 (C) Factors Affecting Temperature of Fire-Exposed Concrete Slabs.
By T. T. Lie and G. Williams-Leir

CIB W14/80/67 (C) Safety Factors for Fire Loads.
By T. T. Lie

CIB W14/80/68 (C) Fire Resistance of Structural Steel.
By T. T. Lie

CIB W14/80/69 (C) Calculation of the Fire Resistance of Composite Concrete Floor and Roof Slabs.
By T. T. Lie

CIB W14/80/70 (USSR) Analysis of Fire Resistance Limit of Metal Structures.
By A. I. Yakovlev and P. C. Labozin.

CIB W14/80/71 (DK) Fire Engineer Education 1980. Report 8005.
By F. B. Olesen

CIB W14/80/72 (DK) Bond Between Concrete and Deformed Bars Exposed to High Temperatures, Technical Univ. of Denmark.
By K. Hertz.

CIB W14/80/73 (DK) On Fire Properties of Surface Board and Sheet Materials, Technical Univ. of Denmark.
By T. Jakobsen.

CIB W14/80/74 (NL) The Movement of Smoke in Buildings on Fire, Calculated by Means of a Dynamic Computer Model, Taking Into Account the Interaction Between Temperatures Throughout the Building and Smoke Spread, Detection and Control Systems, Institute of Applied Physics, TNO Delft.
By H. A. L. van Dijk.

CIB W14/80/75 (F) Controle Des Fumees Dans Les Batiments Compartimentes (in French), CSTB.
By A. M. Majou.

CIB W/14/80/76 (F) Cadre de Discussion Sur Theme: Emission de Fumee (Smoke Emission).

CIB W14/80/77 (S) Simulating the Early Fire Growth in Residential Rooms, FOA Rapport C 20352-A3.
By Bengt Hagglund.

CIB W14/80/78 (S) Recent Developments in Mathematical Modeling of Fire Growth.
By S. E. Magnusson.

CIB W14/80/79 (D) Moisture Transport in Solid Concrete Structures at High Service Temperatures.
By Prof. Kordina

Appendix C

CURRENT FIRE RESEARCH ACTIVITIES
SELECTED SUMMARIES

Australia	Experimental Building Station
Denmark	Aalborg University Centre
Finland	Technical Research Centre
Germany	University of Karlsruhe
Greece	Technical University of Thessaloniki
Japan	Japanese Assn of Fire Science and Engineering Architectural Institute of Japan Administrative Committees
U.S.A.	Forest Products Laboratory

EXPERIMENTAL BUILDING STATION

DEPARTMENT OF HOUSING AND CONSTRUCTION

PRINCIPAL AUSTRALIAN FIRE RESEARCH PROJECTS

REPORT TO 1980 MEETING OF CIB COMMISSION W 14

STRUCTURES

Fire-resistance of loadbearing walls. A series of walls is being tested to ISO 834 to establish data on the interplay of variables such as wall height, wall thickness, level of applied load and physical properties of the mortar and the masonry units. It is hoped the data obtained will make it possible to predict the fire resistance of any wall once the thermal expansion and the thermal diffusivity of the individual unit of burned-clay brick, calcium-silicate brick or concrete block has been measured.

FIRE INVESTIGATIONS

Statistics. A national committee is devising a scheme by which data on fire experience can be collected in Australia that will correspond to that collected in the U.S.A. by the National Fire Control and Prevention Administration.

Preflashover fires. With the collaboration of fire brigades visits are made to fire sites to study what materials are first involved in fire and what materials contribute markedly to fire development. This background data is needed for the study of hazard assessment.

TEST METHODS

Results obtained using established and proposed laboratory test methods are being compared with real fire experience to determine their suitability for use in assessing fire hazard. Lining materials, furniture, mattresses, drapes, clothing and carpets are being studied individually.

NATIONAL CODES

1. The sensitivity and reliability of single-point smoke detectors is being studied in order to produce a national code for such domestic units.

2. The national code for the design of air-handling systems to assist in the control of flow of smoke from fires in multi-storeyed buildings has been revised and amended.

3. A national code for the design, installation and maintenance of automatic water-sprinkler systems which is based on the FOC Rules of the United Kingdom has been prepared in a form which assists a designer and yet can be called up in building regulations.

4. The provisions of the national codes for the design of normally reinforced and prestressed concrete structures are being revised to align with the recommendations of the FIP.

5. Rules relating temperature and levels of stress to determine critical conditions for the several grades of structural steels are being drawn up for possible inclusion in the national code for steel structures.

J. J. Keough
April 1980

INSTITUTTET FOR BYGNINGSTEKNIK
INSTITUTE OF BUILDING TECHNOLOGY AND STRUCTURAL ENGINEERING
AALBORG UNIVERSITETSCENTER DANMARKSGADE 19 POSTBOKS 159 DK-9100 AALBORG TLF. (08) 16 05 33

THE FIRE LABORATORY OF THE AALBORG UNIVERSITY CENTRE

RESEARCH-PROJECTS CARRIED OUT FROM FEBRUARY 1979 TO MAY 1980

PROJECT 1: CHARRING RATE IN WOOD LOADED BY DOWELS AT ELEVATED TEMPERATURES

A partial project concerning the fire resistance of mechanical fasteners in wood structures. By 144 tests the influence of the following parameters on the charring rate has been investigated:

Steel temperature	(340, 380, 420, 460, 500 and 540 °C)
Embedding stress	(3, 6, 9 and 12 MPa)
Force/fibre-angle	(0° and 90°)
Diameter of dowel	(12 and 25 mm)

Report: AUC/IFB no. 7904 (in Danish).

PROJECT 2: FIRE RESISTANCE OF PRESTRESSED RECTANGULAR CONCRETE BEAMS

An investigation of the thermal proporties, deflection and load-bearing capacity of simply supported, rectangular prestressed concrete beams exposed to fire.

By 8 full scale tests the temperatures in 25-30 internal points have been measured by thermo-couples built-in, and the load and the deflection during the fire-exposure corresponding to 3 different temperature/time-curves have been measured. Residual capacity measured.

Report: under preparation.

PROJECT 3: FIRE RESISTANCE OF GLULAM BEAMS

Pilot-tests for verification of the deformation behaviour of glulam beams based on a "realistic" assumption of the charring rate and on a simplified model of the influence of temperature on the mechanical proporties inside the charring zone.

By 4 full scale tests the internal temperatures have been measured by thermo-couples built-in, and the deflection during the tests have been measured.

Report: AUC/IFB no. 7905 (in Danish).

PROJECT 4: MECHANICAL PROPORTIES OF STEEL AT ELEVATED TEMPERATURES

Investigation of creep parameters and stress/strain-relations of structural steel at elevated temperatures.

An electrically heated furnace has been constructed for the purpose and used in combination with a standard load-testing equipment for determination of stress/strain-re-

lations of some Danish construction steel at temperatures 20-600°C.

Report: under preparation.

PROJECT 5: FIRE RESISTANCE OF CENTRALLY LOADED STEEL COLUMNS

Investigation of the load-bearing capacity of centrally loaded steel columns at various temperature levels.

A series comprising 30 full scale tests with unprotected specimens has been carried out, each of them carefully surveyed before testing.

Testing variables:

Sections: HE 100A and RHS 100×60×5,

Lengths: 2400, 3600 and 4200 mm,

Temperatures: 20, 200, 400, 550°C constant (load: 0 - $P_{ult.}$) and variable 20°C - $T_{ult.}$ (at constant load: expected $P_{ult.}$ at 400°C).

Report: AUC/IFB no. 8003 (preliminary report in Danish, only comprising the testing procedure and the testing results).

PROJECT 6: FIRE RESISTANCE OF JOINTS IN STEEL STRUCTURES

Experimental determination of the load-bearing capacity of various kinds of bolted joints at elevated temperatures.

A preliminary series comprising 40 tests is being carried out in the combined furnace/testing-equipment of the laboratory.

Testing variables:

Joints: Tension bolts, shear bolts and friction bolts,

Bolts: D = 15 mm,

Temperatures: 20, 200, 400, 600°C constant and 20°C after previous heating to 600°C (load: 0 - $P_{ult.}$)

Report: under preparation.

FBO/12th May 1980

REPORT

CIB/W14 meeting
Athens, Greece, May 19...23.1980

Technical Research Centre of Finland (VTT)
Fire Technology Laboratory (PAL)

1. Organisation and staff

Sections (s)	Persons now (univ.graduates)	Change after 1.1.79
1. Administration	7 (1)	+1 (0)
2. Structural fire prevention	10 (5)	+3 (2)
3. Fire fighting engineering	4 (3)	0
4. Fire safety of heating devices	3 (1)	0
5. Fire chemistry and physics	1 (1)	0
6. Fire safety of textiles	4 (4)	0
7. Type approval and quality control	3 (1)	+1 (0)
	32 (16)	+5 (2)

In fact the staff is bigger because the specialists of other laboratories of VTT are available.

2. Building. 29500 m^3, 6044 m^2, modern, major part completed -78. Furnace hall (7500 m^3), fire fighting hall (5500 m^3), liquefied gas heater hall (700 m^3), heating device hall (1300 m^3), ordinary lab. rooms (813 m^2), etc.

3. Equipments, 2 furnace (horizontal, vertical), devices for testing detectors and sprinklers, extinguishing testing, smoke density chamber, dust explosion testing, hot gas generator for testing small chimneys, etc.

4. Methods as much as possible according to internat.known stadards.

5. Research projects (major)

s 2.1. Fire resistance of gluelam timber structures
- effect of temperature and moisture on the strength of wood and glued joint
- fire endurance of bearing wooden structures
- fire endurance of joints.

2. Behaviour of concrete structures in fire
- fire properties of concrete (recently started).

s 3.3. Development of test methods for portable extinguishers.

s 4.4. Small chimneys.
5. The safe distance of masonry fire places.

s 5.6. Dust explosion research
- fire safety of peat power plants
- spontaneous ignition of peat
- explosibility of peat dust as a function of moisture content

s 6.7. Flammability of drapery materials.
8. Sleeping bags, multi layered garment.
9. MAFT, heat transfer rate for burning fabrics.
10. Ignitability of upholstery (smokers' materials).
11. Ignitability flame spread properties, smoke generation and toxicity of burning gases of interior materials.

s 7. 320 products under quality control.

6. Future programmes (nearest practical goals)
Data acquisition and handling.
Test chamber for testing room fires.

P.Loikkanen

Forschungsstelle für Brandschutztechnik
an der Universität Karlsruhe (TH)

7500 Karlsruhe 21, den 16.4.1980
Hertzstraße 16, Postfach 6380 Dr.Se/st
Telefon (0721) 608-4473

CIB W14 Meeting in Athens 18-23 May 1980

Current research programme at the Forschungsstelle für Brandschutztechnik an der Universität Karlsruhe, Karlsruhe, Federal Republic of Germany

Model fire tests to determine the burning process of solid materials

Purpose: To examine the burning characteristics of free-burning wooden cribs in order to assess their effect as fire load in model rooms, and to assess the efficiency of fire fighting equipment.
In addition, burning mechanisms will be investigated and mathematical models developed. Results will be analysed to find out whether they can be applied to other solid fuels.

Publications:
Brein, D., and Schatz, H., AGdI Research Report No. 27(1975)
Brein, D., AGdI Research Report No. 30(1976), No. 34(1978), and No. 38(1979)

Fire and extinguishing tests in a full scale test room

Purpose: To investigate the burning characteristics of various types of fuel loads in a test room of average natural size and to examine the extinguishing efficiency of extinguishing agents, in particular of CO_2 and halons. In addition it is one of the aims of the investigation to determine suitable extinguishing agents or combinations thereof which probably could reduce the water damage normally connected with the extinguishing measures carried out during a fire.

Publications:
Fuchs, P., AGdI Research Report No. 29(1975), No. 31(1977), No. 33(1978) and No. 36(1979)
Schatz, H., AGdI Research Report No.32(1978), No. 37(1979), and No.40(1980)

Large scale fire tests on roof constructions and wall linings

Purpose: To evaluate by experimental procedures the burning characteristics of heat-insulated roof constructions and walls with the thermal stress by fire attacking from the underside of roofs and/or by point fire sources.

Publications:
Brein, D., and Seeger, P.G., Report of the Forschungsstelle für Brandschutztechnik an der Universität Karlsruhe 1978
Brein, D., VFDB-Zeitschrift 27(1978), No. 4, pp. 114-120
Brein, D., and Seeger, P.G., Kunststoffe im Bau 14(1979), No. 2,pp.51-56
Brein, D., and Seeger, P.G., Fire and Materials 3(1979), No.3, pp.148-153

Requirements for fire ventilation systems and/or pressurization systems in buildings in order to protect escape routes in the event of fire

Purpose: To determine the required values for the design of ventilation systems and/or pressurization systems installed in buildings in order to prevent the penetration of smoke in escape routes in the event of fire by means of theoretical calculations and tests carried out in a full scale test facility and in real buildings.

Publications:

John, R., and Seeger, P.G., Informationsverbundzentrum Raum und Bau der FhG, Stuttgart, Report (1974)
John, R., and Seeger, P.G., Informationsverbundzentrum Raum und Bau der FhG, Stuttgart, Report No. T 149 (1976)
John, R., Bauwelt 68(1977), No. 29, pp. 988-994
Seeger, P.G., and John, R., VFDB-Zeitschrift 26(1977), No. 3, pp. 77-86
Seeger, P.G., VFDB-Zeitschrift 26(1977), No. 3, pp. 90-99
John, R., revue technique du feu 18(1977), No. 167, pp. 74-81
John, R., VFDB-Zeitschrift 27(1978), No. 1, pp. 34-36, and No. 2, pp. 56-58
John, R., AGdI Research Report No. 35(1978), and No. 39(1980)
John, R., Ki Klima-Kälte-Heizung 7(1979), No. 11, pp. 455-461

Investigation of evacuation processes in buildings as basis for the design of escape routes

Purpose: To determine basic principles for the design of escape routes in buildings of different use by means of theoretical calculations and real evacuation tests carried out in high-rise office buildings (vertical escape routes) and in schools (horizontal escape routes).

Publications:

John, R., and Seeger, P.G., Informationsverbundzentrum Raum und Bau der FhG, Stuttgart, Report No. T 395 (1978)
Seeger, P.G., and John, R., VFDB-Zeitschrift 29(1980), No. 1, pp. 2-7

Dr.-Ing. P.G. Seeger
Director of the Forschungsstelle

THE FIRE SCIENCE IN GREEK UNIVERSITIES AND GENERALLY IN GREECE

(A small experience from the Technical University of Thessaloniki)

In 1975, the necessity for fire research and education was established in the Department of Building Construction and Materials at the School of Technology of Thessaloniki's Aristotle University.

It was integrated into the session of structural Physics (Bau-physik) in relationship with other important factors which have a main influence in buildings design.

The materialization and the progress of that planning did not attempt to avoid some internal difficulties of the to-day's Greek University (perhaps common to other countries also). In addition Greece for various reasons had an impressive delay in that section. It is easy to realize that there is not at this time in Greece any scientific background and a lack of technical literature about this subject. A few generous efforts of the Fire Brigade whilst helpful cannot of course be considered as a scientific background.

Actually, the general use of reinforced concrete in Greek buildings and the rapid post-war rebuilding has not increased, compared with other countries, the percentage of fire incidents in domestic buildings. Thus the Greek common sense is not yet sensitive enough in order to press the responsible authorities for a radical confrontation of the problem. However, the financial damage from the fire at a national level is extremely serious especially for our country which is not included amongst the rich developed industrialized nations.

Moreover a higher-education establishment, in my opinion, has the duty to anticipate the radical social needs and to conduct its research forward to them. In the case of the Technical University at Thessaloniki a beginning about fire research has been realized. That beginning was mainly supported by the students. They actually were interested in the subject and they readily have been engaged on it.

The Department of Building Construction and Materials has followed three special subject areas

a) architecture

b) civil engineering

c) topography - estate management.

The students of the third subject have not at the present moment been involved in the education on fire though forest fires are of considerable importance in Greece, so it has to do with their speciality.

In the first three years until 1978, the lectures on fire were rather limited, because the courses already included so many topics and the experience of the lecturers about fire problems was inadequate. On the other hand there was no special financial support for fire research. Since then, however, the students have been given the option of producing special papers on fire problems, having the possibility of a free choice amongst special subjects. So we had the opportunity of more lecturing and to be engaged with a reasonable number of students who were really interested in the subject. The papers were given in the fifth year of studies as special projects for the students of Architecture and as final diploma papers for the students of Civil Engineering. Some of the topics were:

1) Fire protection in hotels 2) " " in hospitals 3) " " in schools 4) " " in factories (under preparation)	Special projects of Architecture's students

1) Behaviour of prestressed concrete in fire 2) Behaviour of reinforced concrete in fire 3) Fire and the main building materials 4) DIN 4102 (Translation and comments)	Final diploma papers for civil engineering students

These publications are not certainly original or innovative. However, they are generous selections of essential knowledge from the international references and sometimes they are succesful efforts in the application of passive fire prctection methods in the design of special buildings. So, it has succeeded, on one hand in providing an education and a practice on fire for the students and on the other hand the creation of some primary fundamental background introducing fire science and research in the Greek Universities and generally in Greece. We have the ambition to continue and complete this programme. Of course, we try to take advantages of the experience on this section from the other countries and we sincerely hope that the international scientists would not have any objection about that. To save time in this special field concerned with human life and safety is very important. In international communication the helping of one another and the sharing of research work in such problems is an expression of fundamental humanistic ideas.

Some of the problems we met during the course were:

a) A difficulty in the establishment of a sufficient parallel of Greek technical terminology due not so much to the poverty of Greek language but rather in its richness, and to the lack of experience in fire terms also.

b) As already it has been mentioned, a deficiency of any Greek technical literature and of specialist (expert) scientists on the topic.

c) Lack of special laboratories for experimental work. The existing laboratories at the Technical University at Thessaloniki could be made adequate for such experimental work with additional funds and alterations. The most difficult indeed is to man those laboratories with expert scientists and technicians.

There is no parallel activity on the topic of fire in other technical departments (physics, chemical engineering, mechanical and electrical engineering, statistics etc), if there was, it would be a successful contribution to the work and would result in research from several points of view according to the special field of every department.

d) The lecturing staff are engaged in the general courses field of the Department and are usually responsible for a great number of students. Therefore, there are not many opportunities to lecturers for specialization in specific topics.

e) Anyhow, we have tried to give special attention to the following points: On the one hand not to overrate the fire factor respectively with the other factors involved in the building's design, on the otherhand to raise it from the low status which existed under the Greek conditions.

Another important point was to allow the students discovering for themselves how essential such studies were of their training as engineers and for their future involvement in a profession after finishing the University.

Conclusions of this five years' experience:

It is necessary that fire science should enter the curriculum at Universities. The peculiarity of each establishment would define exactly the size and position of that involvement. The subject is related with a number of sciences (chemistry, physics, architecture, engineering, statistics etc). In our opinion each of these Departments could separately be involved in fire research from a specific point of view, but it would be necessary to have general co-ordination between them.

It may be necessary to establish a fire research organization in Greece similar to those existing in other countries.

The planning of research and the decisions especially about the new regulations would be the result of consultation and co-operation amongst the people of the Universities, the fire research establishment and the Greek engineers' associations. It is, of course, impossible to make regulations without Governments' and Fire Brigades' involvement.

At this point we have to say that the opinion and the suggestions of insurance companies and of fire equipment manufacturers would be of a great importance but respectively with the reservation of the financial interests they have.

For successful new regulations in Greece, we believe that the above mentioned co-operation would have a great meaning. Also, it would be necessary for that success to make a careful study of the special conditions of this country coupled with the sharing of problems the other countries already have.

To-day, when there are not yet the above mentioned facilities in Greece, my suggestion would be to accept fundamental principles of other countries' regulations. In addition to that, we ought to make available as many as possible publications on fire as instructions and guides to the engineers and constructors and generally to the public.

K Papaioannou
Civil Engineer-Lecturer
of Thessaloniki's University

Department of Building
Construction and Materials

BUILDING FIRE RESEARCH ACTIVITIES IN JAPAN

written by S.SUGAWARA from
member Institutes and discussions

theme	chairman	level of research: initial	middle	final
1. The Activities in The Japanese Association of Fire Science and Engineering (JAFSE)				
a. Systems Approach to Building Fire Safety	Dr.T.Wakamatsu		*	
b. Smoke Load and Toxic Hazards	Dr.F.Saito		*	
c. The Effective Investment in Disaster Protection Facilities	Dr.K.Kawagoe (seminar)			
d. Others (ex.Fire Fighting for underground Urban Facilities)				
2. The Activities in The Architectural Institute of Japan (AIJ)				
a. Some Calculation Rules in Structural Design for Building Fire Resistance	Dr.H.Saito		*	
b. The Committee on The Publication of Fire Protective Materials Handbook	Dr.T.Moriwaki		*	
c. Japan Commission on ISO/TC92	Dr.K.Kawagoe			
d. Others (ex. pre-CCFT Works)				
3. The Activities in Several Administrative Committees				
a. Fire Protection Design for Dwelling Houses	Dr.K.Kishitani Dr.S.Sugawara			*
b. Japan Commission on ISO/TC21	Dr.K.Kawagoe Dr.K.Kishitani			
c. Standardization for Floor or Wall Penetration Works	Dr.S.Sugawara		*	
d. Systems Approach to Disaster Protection Facilities	Dr.K.Kawagoe Dr.K.Kishitani	*		
e. Urban Fire Protections	Dr.K.Kawagoe		*	
f. General Concern for Building Fire Safety in USA-JAPAN Joint Committee	Dr.K.Nakano			
g. Others (ex.Testing Fire Door)				

4. Individual Activities

(ex.) Fire Modelling (Dr.T.Tanaka,Mr.Y.Hasemi)
Smoke Control (Dr.T.Wakamatsu)
Psychological Approach in Fire (Dr.T.Jin)
Stochastic Approach to Fire Hazards (Mr.Y.Morishita)
Inspecting and Repairing Methods for Buildings Suffered from Fire (Dr.K.Nakamura)
Others

Active Fire Research Studies

U.S. Forest Products Laboratory
Madison, Wisconsin

April 1, 1980

Fire Design Engineering

Fire Endurance Under Design Load of Walls of One-Story Housing Structures of Sandwich and Wood-Frame Construction.

To obtain information on the actual endurance times of structural sandwich and wood stud walls under design loads when exposed to full-scale structure interior fires, influence of thermal protection, comparison of endurance performance to laboratory-scale results, and study of interior fire buildup.

Fire Endurance of Light-Frame Floors.

To obtain test data on the variability of light-frame floor fire endurance for use in a probabilistically based predictive model under development in another study.

Durability to Exterior Weathering of Some Leach-Resistant Fire-Retardant Treatment Systems.

To determine the durability, as measured by fire performance of selected leach-resistant fire-retardant treatment systems in outdoor exposure, and to determine the equivalent of weathering chamber to long-term outdoor weathering.

Measurement of Smoldering Tendency in Fire-Exposed Sound-Deadening Boards.

To conceive, formulate, and develop an apparatus and method for measuring the tendency of fire-exposed rigid wood-fiber insulation board to smolder.

Transient Moisture Gradient in Fire-Exposed Wood Slab.

To characterize the transient moisture gradient in wood slab exposed to fire on one face.

Thermal Characteristics of Thick Red Oak Structural Particleboard.

Evaluate the thermal characteristics of thick red oak structural particleboard which is part of the major objective (evaluating the technical feasibility of the decking panels based on simulated structural and use performance testing of full-size panels) of study 3-78-1 (RWU 4151).

Manual on Evaluation, Maintenance, and Upgrading of Timber Structures--Fire Considerations.

To assemble information and prepare a paper on the influence of fire on serviceability of wood structures and designing to avoid failure after fire exposure.

Improved Efficiency of Boron Fire-Retardant Treatment of Cellulosic Insulation and Wood Fiber-Based Products.

Determine relative efficiency of different methods of application of boron fire retardants to cellulosic loose-fill wood-base insulation as indicated by fire performance--flame spread and smoldering resistance and permanency of treatment. Establish the fundamental principles affecting fiber-flame retardant interaction.

Correlation of NBS-AMINCO Smoke Density Chamber with Larger Scale Experiments; Study of Smoke Accumulation During Early Stages of Fire Exposure.

To characterize the accumulation of smoke in an enclosure (the NBS smoke chamber) during the early stages of a fire so that the information that is developed may be extended to larger enclosures in subsequent studies.

Heat-Release Rate Measurement of Full-Scale Assemblies Using a Large Vertical Furnace.

1. Develop the substitution and the oxygen depletion methods. 2. To use them to measure heat release rates of typical fire-retardant-treated wood stud/gypsum board wall assemblies in the Forest Products Laboratory E-119 fire endurance test furnace.

Wood-Based Paneling as Thermal Barriers.

To develop a procedure and data that will permit one to make reasonable estimates of the thermal protection afforded fire-exposed wall assemblies by various types and thicknesses of surface panels.

Fire Endurance Reliability Formulation for Heavy Timber Beams.

Using the available strength data on laminating grades for glue-laminated beams, develop a probabilistically based strength model to predict failure for fire-exposed beams. Investigate the safety benefits of controlling grade order of laminates.

Effect of Red Oak Variability on Fire Test Results.

Determine performance variability of red oak flooring in ASTM E-286 laboratory fire tests conducted at the Forest Products Laboratory.

Influence of the Redrying of Fire-Retardant-Treated Structural Plywood on Mechanical Properties.

Study will examine the effects on the plywood quality following redrying after fire-retardant treatment. The results among different redrying processes and fire-retardant treatment chemicals will be compared. The effect of reduction of redrying time on the mechanical properties of redried plywood when treated by various commercial fire-retardant chemicals will be investigated.

Wood Strength Prediction Using Accelerated Means.

To develop theory and conduct validating experiments using moderately elevated temperature and/or moisture exposures to quantify their time related effect on softwood.

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	14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

A summary is presented of the discussions during the 14th Meeting of CIB Commission W-14 on Fire in Athens, Greece. A total of 48 delegates from 14 countries exchanged information on building fire safety during Group and Plenary Meetings covering the following topics: building codes; fire costs; fire loss statistics; fire engineering education; structural fire protection (including material properties, classification of structures, calculation rules, and full-scale fire tests); smoke control and emission; and mathematical modeling. Three workshops are planned during 1981 to cover the topics "Fire Safety Design," "Fire Engineering Education" and "Modeling of Fires." A list of papers circulated to delegates during the last two years is included for reference.

17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)

Buildings; building codes; CIB; Commission W-14; education; fire endurance; fire loss statistics; fire modeling; fire safety; fire tests; smoke control.

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